TENNELEC

INNOVATION TO MAKE IT FIRST . . .

RELIABILITY TO MAKE IT LAST

TENNELEC - A Quarter Century of Service

Founded in 1960 by Edward Fairstein, one of the world's leading designers and authors in the nuclear electronics field, Tennelec has always developed and provided the highest performance, most reliable instrumentation for your nuclear research. Your continuing trust and confidence in us has made this possible.

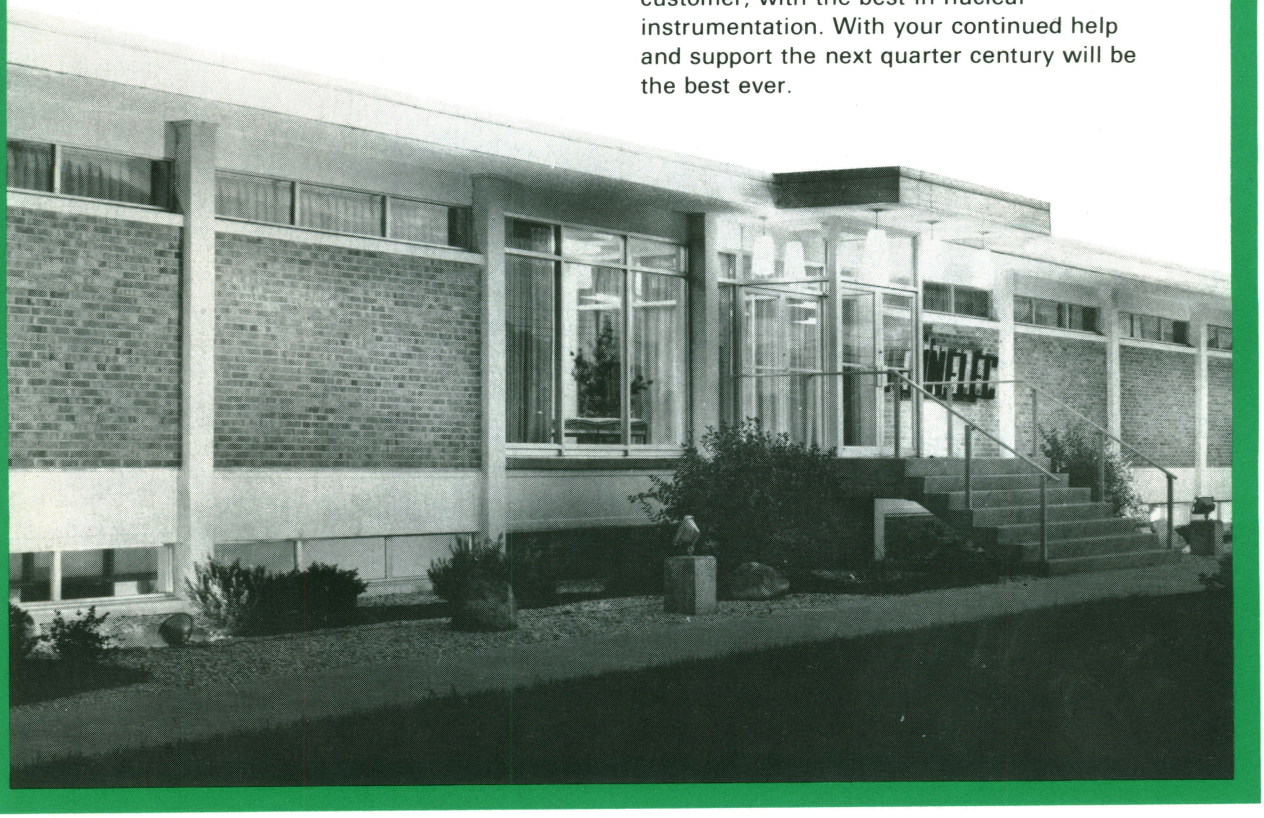
In the early 1960's Tennelec set the standards of performance by designing and manufacturing the very first ultra low-noise charge-sensitive preamplifier for silicon semiconductor detectors. In 1964, with the advent of advanced transistor technology, Tennelec designed and manufactured the model TC 200 linear amplifier. The TC 200, using an "active element" pulse shaping technique, represented a radical departure from contemporary linear amplifiers. Built to Tennelec's most stringent requirements for performance and reliability, the TC 200 quickly became the worldwide laboratory standard, with many still in productive use today.

The Pulsed Analog-to-Digital Converter and Encoding (PACE) System used a patented series-parallel encoding technique that enabled it to digitize up to 8192 channels of data in less than 4.5 μ seconds. The PACE System was the forerunner of today's fast analog-to-digital converters whose speed is only now rivaling their Tennelec predecessor.

The 1970's were a period of diversification and realignment for Tennelec. After a brief venture into the commercial products marketplace, Tennelec realized that its real strength was in nuclear instrumentation. Revitalized with new managerial talent, Tennelec focused on its old marketplace and laid the groundwork to emerge as a leader in the next decade.

In 1982, Tennelec acquired the technology to manufacture silicon surface barrier detectors. The next year, Tennelec purchased the high purity germanium crystal growing facility of a major corporation and moved the entire division to its headquarters in Oak Ridge, Tennessee. Here, a new 9,000 square foot building houses both divisions of the semiconductor manufacturing facility.

Now, in 1985, we ask you to celebrate our silver anniversary with us. We also want to express our sincere thanks to each of our loyal customers because we realize that without you, none of this would have been possible. In 1985, all of us at Tennelec rededicate ourselves to providing you, our customer, with the best in nuclear instrumentation. With your continued help and support the next quarter century will be the best ever.



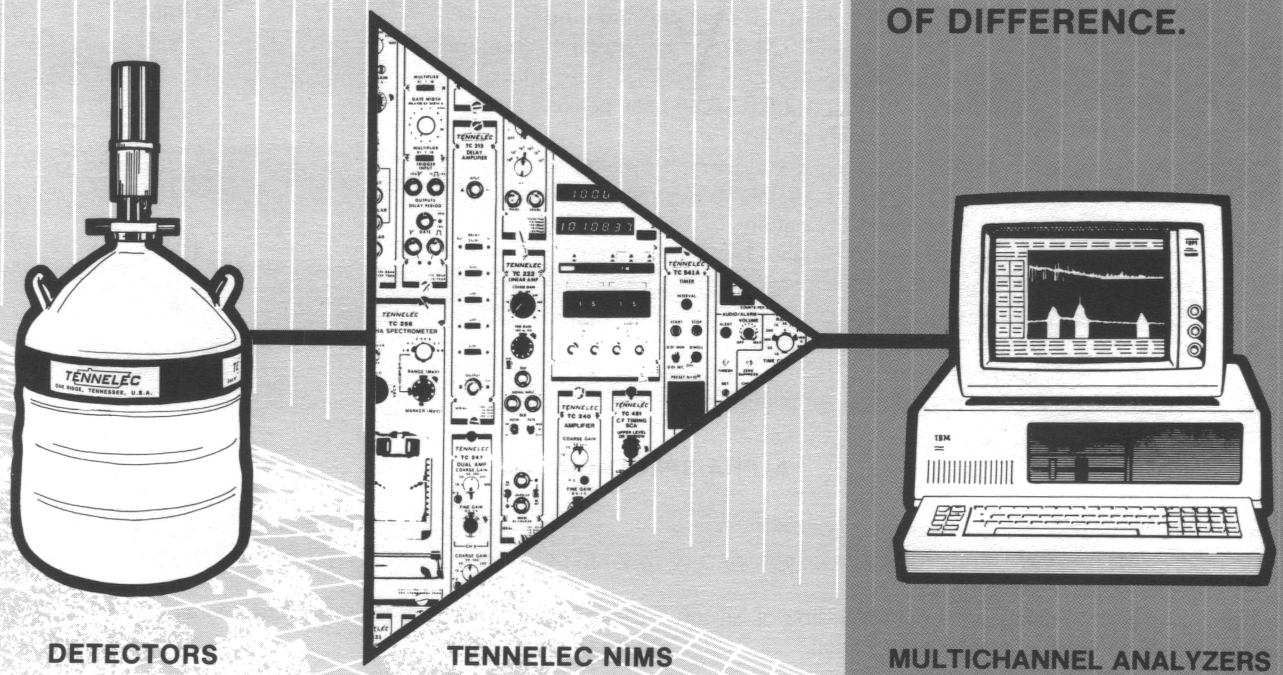
TENNELEC INC. 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA

PHONE 615-483-8405 TWX 810-572-1018

Nuclear Instrumentation Modules

TENNELEC, INC.

FOR PERFORMANCE, RELIABILITY AND SERVICE...THE NAME THAT MAKES A WORLD OF DIFFERENCE.



DETECTORS

TENNELEC NIMS

MULTICHANNEL ANALYZERS

NIM PRICE LIST APRIL 1986

TENNELEC, Inc.
601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone (615) 483-8405 TWX 810-572-1018

REPRESENTED WORLDWIDE

TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

PREAMPLIFIERS

Model No.	Description	NIM Width	Price (US $)
TC 145	Scintillation Detector Preamplifier		$195
TC 148A	G-M Tube Preamplifier		155
TC 154	Photomultiplier Tube Base	12 pin base	175
TC 154A	PM Tube Base with built-in preamplifier	12 pin base	295
TC 155	Photomultiplier Tube Base	14 pin base	175
TC 155A	PM Tube Base with built-in preamplifier	14 pin base	295
TC 170	FET Spectroscopy Preamplifier (Lo Cap)		655
TC 171	FET Spectroscopy Preamplifier (Hi Cap)		655
TC 174	FET Preamplifier for general purpose		375
TC 175	FET Preamplifier for proportional counters		525
TC 178	Quad Preamplifier		1,425
TC 178P	Quad Pulser	1 NIM	775

AMPLIFIERS

TC 202BLR	Spectroscopy Amplifier 0.53 μsec to 2.4 μsec time constant	1 NIM	$895
TC 205A	Research Spectroscopy Amplifier	2 NIM	1,395
TC 215	Delay Amplifier 0.25 μsec to 4.75 μsec delay	1 NIM	525
TC 240	General Purpose Amplifier 2.0 μsec peaking time	1 NIM	425
TC 241	Spectroscopy Amplifier 1.0, 3.0, and 6.0 μsec peaking times	1 NIM	495
TC 241-02	2.0 μsec Unipolar delay option		125
TC 242	Spectroscopy Amplifier 1,2,4,8,16,24 μsec peaking times	1 NIM	1,075
TC 242-02	2.0 μsec Unipolar delay option		125
TC 243	Spectroscopy Amplifier, triangular/gaussian shaping	1 NIM	1,125
TC 244	Spectroscopy Amplifier, w/Pileup Rejector		1,295
TC 244-02	2.0 μsec Unipolar delay option		150
TC 246	Linear Amplifier and Single Channel Analyzer	1 NIM	795
TC 247	Dual Amplifier 2.0 μsec peaking times	1 NIM	795
TC 248	Fast/Slow Amplifier	1 NIM	775
TC 248-02	2.0 μsec Unipolar delay option		125
TC 252	Biased Amplifier	1 NIM	585
TC 253	Dual Sum and Invert Amplifier	1 NIM	325

ALPHA SPECTROMETERS

TC 256	Alpha Spectrometer (without detector)	2 NIM	$1,795
TC 257	Alpha Spectrometer - 2" sample size (without detector)	3 NIM	2,250

NOTE: Tennelec manufactures a complete line of Silicon Surface Barrier Detectors for use in the Model TC 256 or TC 257. Contact the factory for additional information.

LINEAR GATES, COINCIDENCE AND LOGIC PROCESSORS

TC 306	Linear Router and Multiplexer	1 NIM	$875
TC 307	Linear Gate	1 NIM	375
TC 308	Dual Linear Gate	1 NIM	695
*TC 309	Linear Gate and Stretcher	1 NIM	625
*TC 310	Dual Linear Gate and Stretcher	1 NIM	1,195
TC 404A	Multipurpose Coincidence	2 NIM	475
TC 410A	Delay and Gate Generator	1 NIM	465
TC 412A	Nanosecond Delay, 1 to 63 nanoseconds	1 NIM	355

DISCRIMINATORS AND SINGLE-CHANNEL ANALYZERS

TC 450	Single-Channel Analyzer	1 NIM	$395
TC 451	Constant Fraction Timing Single-Channel Analyzer	1 NIM	675
*TC 452	Quad Single-Channel Analyzer with DVM	1 NIM	995
TC 453	100 MHz Constant Fraction Discriminator	1 NIM	795
TC 454*	200 MHz Quad Constant Fraction Discriminator with gating	1 NIM	1,895
TC 455*	200 MHZ Quad Constant Fraction Discriminator without gating	1 NIM	1,895

CABLES, CONNECTORS, TERMINATORS (Continued)

Model No.	Description	Price (US $)
ADT-1	Preamp power adapter	20
ADT-2	Preamp power adapter with Test Input and Energy Output BNC	25

TEES, TERMINATORS, AND ADAPTERS

ATT-10	X10 Amplifier Input Attenuator	$35
NC-TEE	BNC Tee Connector (one male, two female)	10
NC-TERM-50	BNC Terminator, 50 ohms	15
NC-TERM-93	BNC Terminator, 93 ohms	15
NC-MTB	Microdot (female) to BNC (male) adapter	50
NC-BTM	BNC (female) to Microdot (male) adapter	50
NC-LTEE	LEMO Tee Connector (one male, two female)	30
NC-LTERM	LEMO Terminator, 50 ohms	25
NC-BTB	BNC (female) to BNC (female) adapter	15
NC-BTL	BNC (male) to LEMO (female) adapter	20
NC-LTB	LEMO (male) to BNC (female) adapter	20
NC-BTM-VF	BNC (female) to Microdot (male) Vacuum feed through connector	70
NC-MTM-VF	Microdot (female) to Microdot (male) Vacuum feed through connector	65

INSTRUMENT CABINET

CAB-8	Instrument Cabinet, 8¾" x 19" Panel, 21½" Deep	$395

SIGNAL CABLES

RG-58, 50 ohm impedance cable with BNC-BNC Connectors

NC-581-0.5	0.5 foot long	$15
NC-581-01	1 foot long	15
NC-581-02	2 feet long	15
NC-581-06	6 feet long	15
NC-581-12	12 feet long	15

RG-62, 93 ohm impedance cable with BNC-BNC Connectors

NC-621-0.5	0.5 foot long	$15
NC-621-01	1 foot long	15
NC-621-02	2 feet long	15
NC-621-06	6 feet long	15
NC-621-12	12 feet long	15

RG-58, 50 ohm impedance cable with LEMO-LEMO Connectors

NC-58L-0.5	0.5 foot long	$30
NC-58L-01	1 foot long	30
NC-58L-02	2 feet long	30
NC-58L-06	6 feet long	30
NC-58L-12	12 feet long	30

RG-174, 50 ohm impedance cable with LEMO-LEMO Connectors

NC-174L-0.5	0.5 foot long	$30
NC-174L-01	1 foot long	30
NC-174L-02	2 feet long	30
NC-174L-06	6 feet long	30
NC-174L-12	12 feet long	30

RG-174, 50 ohm impedance cable with Microdot-Microdot Connectors

NC-174M-0.2	2 inch long	$45
NC-174M-01	1 foot long	45
NC-174M-02	2 feet long	45
NC-174M-06	6 feet long	45
NC-174M-12	12 feet long	45

RG-174, 50 ohm impedance cable with Microdot-BNC Connectors

NC-174MB-01	1 foot long	$70
NC-174MB-02	2 feet long	70
NC-174MB-06	6 feet long	70
NC-174MB-12	12 feet long	70

NaI (Tl) DETECTORS (Continued)

Standard Well In Right Circular Cylinder
(all units fit TC 155 and TC 155A)

Model No.	Description	NIM Width	Price (US $)
	Diameter x Height		
TD 51 SP 51	2" x 2" NaI(Tl) Crystal with 1" x 1.5" deep well, 2" PMT		$595
TD 76 SP 76	3" x 3" NaI(Tl) Crystal with 1" x 2.0" deep well, 3" PMT		1,495

THIN WINDOW X-RAY DETECTORS, INTEGRAL CRYSTAL-PMT
(All X-Ray Detectors fit TC 154 and TC 154A)

	Diameter x Height		
TD 25 SX 1	1" dia. x 1mm thick NaI(Tl) Crystal with 5 mil Be entrance window, 1.5" PMT;		$735
TD 38 SX 2	1½" dia. x 2mm thick NaI(Tl) Crystal with 5 mil Be entrance window, 1.5" PMT;		865

GAS DETECTORS

TD 2902	0.6" diameter GM Tube and Stand		$95
TD 2903	1.4" diameter GM Tube and Stand		135
TD 2904	0.5" diameter Proportional Counter with SHV connector		995
TD 2905	1.0" diameter Proportional Counter with SHV connector		1,095

ACCESSORIES

TV-1	Vacuum Chamber, front access		$495
TC 2902G	Lead Shield for 1" diameter GM Tube or Proportional Counter down-looking with planchet holder base.		645
TC 2902C	Lead Shield for 1" or 2" diameter NaI (Tl) detector, up-looking, solid top plug.		745
TC 2902W	Lead Shield for 1" or 2" diameter NaI (Tl) well detector, up-looking, top plug with access hole.		745
TC 2903C	Lead Shield for 3" diameter NaI (Tl) detector, up-looking, solid top plug.		1,195
TC 2903W	Lead Shield for 3" diameter, NaI (Tl) well detector, up-looking, top plug with access hole.		1,195

BLANK MODULES

NIM-B1W	Blank NIM Module	1 NIM	$60
NIM-B2W	Blank NIM Module	2 NIM	65
NIM-B3W	Blank NIM Module	3 NIM	70
NIM-B4W	Blank NIM Module	4 NIM	75

BLANK FRONT PANELS

NIM-BP1	Blank NIM Front Panel	1 NIM	$20
NIM-BP2	Blank NIM Front Panel	2 NIM	20
NIM-BP3	Blank NIM Front Panel	3 NIM	25
NIM-BP4	Blank NIM Front Panel	4 NIM	25

CABLES, CONNECTORS, TERMINATORS

Preamplifier Signal and Power Cable Amphenol 17-20090 to Amphenol 17-10090

NC-OPA-12	Preamplifier Signal and Power Cable, 12 feet length Amphenol 17-20090 to Amphenol 17-10090 Connectors (For TENNELEC Preamplifiers with S/N <2000)	$75
NC-PAC-10	Preamplifier Signal and Power Cable, 10 feet length (For TENNELEC Preamplifiers with S/N >2000)	65

COUNTERS, TIMERS, CONTROLLERS, PRINTER AND RATEMETERS

Model No.	Description	NIM Width	Price (US $)
TC 525	1 MHz Linear Ratemeter	1 NIM	$525
TC 526	100 MHz Linear Ratemeter	1 NIM	595
TC 527	100 MHz Log/Lin Ratemeter	2 NIM	995
TC 529	Alarm Control	1 NIM	495
TC 530-01	Buffered Parallel output option (for TC 532, TC 533 and TC 534)		245
TC 531	100 MHz Counter, non-printing	1 NIM	425
TC 532	100 MHz Counter, 7 decade	2 NIM	435
TC 533	100 MHz Counter, printing	2 NIM	650
TC 534	100 MHz Counter and Timer, printing	2 NIM	895
TC 535P	Multiscaler, 3 Counters (85 MHz) and 1 Timer, printing	3 NIM	1,450
TC 536	100 MHz Counter and Timer, non-printing	1 NIM	695
TC 541A	Timer, Recyclable, non-printing	1 NIM	395
TC 546P	20 MHz Counter, printing	1 NIM	675
TC 547P	20 MHz Timer/Counter, printing	1 NIM	875
TC 566A	Time of Day/Time of Year Clock, printing	1 NIM	795
TC 576	Buffered Printer	3 NIM	1,495
TC 576-01	Pack of 3 rolls of paper for the TC 576 printer		15
TC 588	Buffered Printout Control/Interface (RS-232-C and 20mA)	2 NIM	995
TC 588-01	RS-232-C Cable, 10 feet long		70
TC 588-02	20mA Cable, 10 feet long (Also usable with TC 589)		35
TC 589	Buffered Interface (IEEE standard 488 and 20mA)	2 NIM	995
*TC 589-01	IEEE 488 Cable, 12 feet long		150
TC 599	Howler, audible ratemeter accessory	1 NIM	295

PULSER

*TC 813	Pulser	1 NIM	$375

NIM BINS AND POWER SUPPLIES

TB3	NIM bin (parallel wired power distribution)	12 NIM	$475
TC 911	Power Supply for TB3, ±12V, ±24V		525
TC 911-6	Power Supply for TB3, ±6V, ±12V, ±24V		950
MB1/TC 909	Minibin and Power Supply, ±12V, ±24V	6 NIM	850
MB2/TC 910	Midibin and Power Supply, ±12V, ±24V	10 NIM	895
TB3/TC 911	NIM Bin and Power Supply, ±12V,±24V	12 NIM	875
TB3/TC 911-6	NIM Bin and power Supply, ±6V, ±12V, ±24V	12 NIM	1,295
*BG OPTION	Bin Gate Option for TB3, TB3/TC 911, or TB3/TC 911-6	(additional)	+125

HIGH VOLTAGE AND DETECTOR BIAS SUPPLIES

TC 908	Detector Power Supply, 0 to ± 1kV, 100μA	1 NIM	$385
TC 930A	Portable Power Supply for Preamps, Modules, Bins		595
TC 948	High Voltage Power Supply, 0 to + 1500V, 1mA	1 NIM	575
TC 950	Detector Bias Supply, 0 to ± 5kV, 100μA	1 NIM	675
TC 952	High Voltage Power Supply with DVM, 0 to ± 3kV, 10mA	2 NIM	875
*TC 953	Dual Detector Power Supply, 0 to ± 1kV with DVM	1 NIM	995

NaI (Tl) DETECTORS

Standard Right Circular Cylinder, Integral Crystal-PMT Assembly (all units fit TC 155 & TC 155A)

	Diameter x Height	
TD 25 S 25	1" x 1" NaI(Tl) Crystal on 2" Photomultiplier Tube	$425
TD 38 S 38	1½" x 1½" NaI(Tl) Crystal on 2" Photomultiplier Tube	495
TD 51 S 51	2" x 2" NaI(Tl) Crystal on 2" Photomultiplier Tube	535
TD 76 S 76	3" x 3" NaI(Tl) Crystal on 3" Photomultiplier Tube	1,375

** Additions or Changes* *★ Requires ± 6 volts*

HIGH VOLTAGE CABLES

Model No.	Description	NIM Width	Price (US $)
RG-59, 75 ohm impedance H.V. Cables			
NC-592-02	2 feet long, BNC to MHV Connectors		$30
NC-593-06	6 feet long, MHV to MHV Connectors		25
NC-593-12	12 feet long, MHV to MHV Connectors		25
NC-594-02	2 feet long, BNC to SHV Connectors		35
NC-595-06	6 feet long, SHV to SHV Connectors		45
NC-595-12	12 feet long, SHV to SHV Connectors		45
NC-596-06	6 feet long, SHV to MHV Connectors		45
NC-596-12	12 feet long, SHV to MHV Connectors		45

MISCELLANEOUS CABLES AND NIM MODULE EXTENDER

NC-ODA-2	2 foot Data Acquisition Cable, Connectors-Amphenol 552929-1		$45
NC-SBCA-05	5 foot cable, from module slot in TB 3 to PG-13 of slave bin.		55
NC-EXC-4	4 foot module extender cable, Connectors-Amphenol 202516-3 and 202515-5.		85
NC-NIM-EXT	NIM Module Extender	1 NIM	295

SPECIAL LENGTH CABLES
(Specify length)

NC-OPA-XX-S	Preamplifier Signal and Power Cable, Amphenol 17-20090 to Amphenol 17-22090 Connectors	$75+1.00/ft
NC-PAC-XX-S	Preamplifier Power Cable for TC 170, TC 171, and TC 174 Preamplifiers	65+1.00/ft
NC-581-XX-S	RG-58, 50 ohm impedance Cable with BNC-BNC Connectors	15+0.50/ft
NC-621-XX-S	RG-62, 93 ohm impedance Cable with BNC-BNC Connectors	15+0.50/ft
NC-592-XX-S	RG-59, 75 ohm impedance H.V. Cable with BNC-MHV Connectors	30+0.50/ft
NC-593-XX-S	RG-59, 75 ohm impedance H.V. Cable with MHV-MHV Connectors	25+0.50/ft
NC-594-XX-S	RG-59, 75 ohm impedance H.V. Cable with BNC-SHV Connectors	35+0.50/ft
NC-595-XX-S	RG-59, 75 ohm impedance H.V. Cable with SHV-SHV Connectors	45+0.50/ft
NC-596-XX-S	RG-59, 75 ohm impedance H.V. Cable with SHV-MHV Connectors	45+0.50/ft
NC-ODA-XX-S	Data Acquisition Cable, Amphenol 552929-1 Connectors	45+0.50/ft
NC-SBCA-XX-S	Slave Bin Cable Connects Module Slot in TB3 with PG-13 of slave bin	55+1.00/ft
NC-EXC-XX-S	Module Extender Cable, Amphenol 202516-3 and 202515-5 Connectors	85+1.00/ft
NC-58L-XX-S	RG-58, 50 ohm impedance Cable with LEMO-LEMO Connectors	30+0.50/ft
NC-174L-XX-S	RG-174, 50 ohm impedance Cable with LEMO-LEMO Connectors	30+0.50/ft
NC-174M-XX-S	RG-174, 50 ohm impedance Cable with Microdot-Microdot Connectors	45+0.50/ft
NC-174MB-XX-S	RG-174, 50 ohm impedance Cable with Microdot-BNC Connectors	75+0.50/ft

Shipping Methods: We normally ship by Motor Freight or UPS. Other shipping methods will be followed at your request.

Warranty: TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices: All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

Payment Terms: 1%10, Net 30 days.

TENNELEC, INC.
601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone (615) 483-8405 TWX 810-572-1018

TENNELEC

TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

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TENNELEC

SYSTEMS AND ACCESSORIES

PRICE LIST

MARCH 1985

Automatic Low Background $\alpha/\beta/\gamma$ Counting

Manual Low Background α/β Counting

Automatic Planchet Counting

Manual Planchet Counting

MANUAL LOW BACKGROUND ALPHA/BETA COUNTING SYSTEMS

LB 1000 MANUAL LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

including.....

* Sample Detector
* Cosmic Guard Detector
* Lead Shielding and Detector Drawer Assembly
* Electronics and Cabinets
* Manual Sample Changer
* Set of Carrier and Inserts
* Installation and Performance Verification[a]
* One Year On-Site Warranty[a]

		Price
LB 1000-1080	Manual System with 1.25" diameter gas flow proportional sample detector with 80 μgm/cm^2 window and 25 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 2" diameter samples.	$14,175
LB 1000-1500	Manual System with 1.25" diameter gas flow proportional sample detector with 500 μgm/cm^2 window and 25 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 2" diameter samples.	$14,100
LB 1000-2080	Manual System with 2.25" diameter gas flow proportional sample detector with 80 μgm/cm^2 window and 25 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 2" diameter samples.	$14,500
LB 1000-2500	Manual System with 2.25" diameter gas flow proportional sample detector with 500 μgm/cm^2 window and 25 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 2" diameter samples.	$14,400
LB 1000-5-3080	Manual System with 3.25" diameter gas flow proportional sample detector with 80 μgm/cm^2 window and 100 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 5" diameter samples.	$17,350
LB 1000-5-3500	Manual System with 3.25" diameter gas flow proportional sample detector with 500 μgm/cm^2 window and 100 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 5" diameter samples.	$17,250
LB 1000-5-5080	Manual System with 5.00" diameter gas flow proportional sample detector with 80 μgm/cm^2 window and 100 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 5" diameter samples.	$17,500
LB 1000-5-5500	Manual System with 5.00" diameter gas flow proportional sample detector with 500 μgm/cm^2 window and 100 inch^2 gas flow cosmic guard detector. Gas regulator, FM 40 flow meter and tubing included. Drawer accepts up to 5" diameter samples.	$17,400
LB 1000-PW	Manual System with 2.00" diameter CaF(Eu)/NaI(Tl) Phoswich sample and guard detector assembly and associated electronics. Drawer accepts up to 2" diameter samples.	$14,500

LB 1000 OPTIONS

* TC 576L Buffered Printer	$ 1,595
* TC 588 Buffered Printout Control with TTY Model KSR 43 Terminal/Printer	$ 2,710
* TC 566A Time of Day/Time of Year Clock	$ 790
* TC 589 Buffered Printout Control for IEEE Standard 488	$ 1,150
* LBM-01 Mobile Cabinet (1 and 2 inch systems only)	$ 1,650[b]
* FM40M Flow Meter with low gas pressure sensor, high voltage disable circuit and gas filter; replaces FM 40 in gas flow systems	$ 425[b]

a Prices for Continental USA only.

b Prices effective with initial system purchase. Retrofit prices slightly higher. Contact TENNELEC.

MANUAL LOW BACKGROUND ALPHA/BETA COUNTING SYSTEMS

		Price
LB 1000 ACCESSORIES		
* Sample Carriers (Accepts 2" x 5/16" planchets)	P/N 6200-0020	$ 15
* Sample Carrier Inserts (1") (Adapts Carrier for 1" x 1/8" planchets)	P/N 6200-0001	$ 10
* Sample Carrier Inserts (2") (Adapts Carrier for 2" x 1/8" and 1" x 5/16" planchets)	P/N 6200-0002	$ 10
* Five inch Sample Carrier	P/N 1400-1059	$ 25
* Five inch Stainless Steel Sample Carrier Inserts		
3" x 1/8" (3.072" ID)	P/N 6200-0118	$ 10
3" x 1/4"	P/N 6200-0119	$ 10
3" x 5/16"	P/N 6200-0120	$ 10
4" x 1/8" (4.412" ID)	P/N 6200-0115	$ 11
4" x 1/4"	P/N 6200-0116	$ 11
4" x 5/16"	P/N 6200-0117	$ 11
5" x 1/8" (5.082" ID)	P/N 6200-0121	$ 12
5" x 1/4"	P/N 6200-0122	$ 12
5" x 5/16"	P/N 6200-0123	$ 12

Note: Insert depths are measured from top of carrier to bottom of insert.

* Detector Assemblies		
LBG 25	25 inch² guard for 1.25" and 2.25" sample detectors	$ 795
LBG 100	100 inch² guard for 3.25"and 5.0" sample detectors	$ 1,500
LBD 1500	1.25" diameter sample detector with 500 μgm/cm² Window	$ 1,155
LBD 1080	1.25" diameter sample detector with 80 μgm/cm² Window	$ 1,230
LBD 2500	2.25" diameter sample detector with 500 μgm/cm² Window	$ 1,455
LBD 2080	2.25" diameter sample detector with 80 μgm/cm² Window	$ 1,555
LBD 3500	3.25" diameter sample detector with 500 μgm/cm² Window	$ 2,050
LBD 3080	3.25" diameter sample detector with 80 μgm/cm² Window	$ 2,150
LBD 5500	5.0" diameter sample detector with 500 μgm/cm² Window	$ 2,200
LBD 5080	5.0" diameter sample detector with 80 μgm/cm² Window	$ 2,300
P/N 6200-0065	2.0" diameter CaF(Eu)/NaI(Tl) Phoswich detector assembly	$ 2,250
* Replacement Windows for gas flow detectors:		
1.25", 500 μgm/cm²	P/N 6200-0035	$ 200
1.25", 80 μgm/cm²	P/N 6200-0036	$ 275
2.25" 500 μgm/cm²	P/N 6200-0037	$ 215
2.25", 80 μgm/cm²	P/N 6200-0038	$ 315
3.25", 500 μgm/cm²	P/N 6200-0039	$ 425
3.25", 80 μgm/cm²	P/N 6200-0040	$ 525
5.0" 500 μgm/cm²	P/N 6200-0041	$ 475
5.0" , 80 μgm/cm²	P/N 6200-0042	$ 575
* Spare Filter Cartridge (for FM40M)	P/N 6200-0047	$ 65
* Gas Tubing (50 feet)	P/N 6200-0031	$ 25
* Low Background System Test Sources (2" diameter)		
LB-14	Carbon-14 0.155 MeV Beta, nominal activity 30,000 dpm	$ 250
LB-90	Strontium-90/Yttrium-90 0.55 and 2.7 MeV Betas, nominal activity 30,000 dpm	$ 250
LB-137	Cesium-137 0.52 MeV Beta, nominal activity 30,000 dpm	$ 250
LB-210	Polonium-210 5.3 MeV Alpha, nominal activity 30,000 dpm	$ 350

2" AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEMS

Price

LB 5100 SERIES I AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

including.....

* Gas Flow Proportional Sample Detector
* Gas Flow Proportional Cosmic Guard Detector
* Lead Shielding and Detector Drawer Assembly
* Electronics and Cabinets
* LB 5110 Microprocessor Controller
* Time of Day/Time of Year Clock
* RS-232-C Data Only Output Port
* Fifty Sample Automatic Sample Changer
* Set of Sample Carriers with 1/8" and 5/16" Deep Inserts
* Gas Regulator, FM40 Flow Meter and Tubing
* KSR 43 Terminal/Printer
* Installation and Performance Verification[a]
* One Year On-Site Warranty[a]

LB 5100-1080-I	Series I Automatic System with 1.25" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$24,175
LB 5100-1500-I	Series I Automatic System with 1.25" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$24,100
LB 5100-2080-I	Series I Automatic System with 2.25" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$24,500
LB 5100-2500-I	Series I Automatic System with 2.25" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$24,400

LB 5100 SERIES I OPTIONS

* LBA-01 Mobile Cabinet	$ 2,850[b]
* LBA-03 100 Sample Capacity (includes additional carriers and inserts)	$ 595[b]
* FM40A Flow Meter with low gas pressure sensor, high voltage disable circuit and gas filter; replaces FM40 flow meter	$ 425[b]

LB 5100-PW PHOSWICH AUTOMATIC LOW BACKGROUND ALPHA/BETA/GAMMA COUNTING SYSTEM — $28,500

including.....

* Two Inch Diameter CaF(Eu)/NaI(Tl) Phoswich Detector
* Lead Shielding and Detector Drawer Assembly
* Electronics and Cabinets
* LB 5120 Microprocessor Controller
* Time of Day/Time of Year Clock
* Dual RS-232-C I/O Ports
* Memory with Battery Back-up
* Remote HV Bias Control
* Fifty Sample Automatic Sample Changer
* Set of Sample Carriers with 1/8" and 5/16" Inserts
* Video Terminal and Printer
* Installation and Performance Verification[a]
* One Year On-Site Warranty[a]

LB 5100-PW OPTIONS

* LBA-01-PW Mobile Cabinet	$ 2,850[b]
* LBA-03 100 Sample Capacity (includes additional carriers and inserts)	$ 595[b]
* LBA-11 IBM PC Disk File Conversion Program	$ 125
* LB 5120-01 Single Drive 5¼" Floppy Disk	$ 1,095
* LB 5120-02 Dual Drive 5¼" Floppy Disk	$ 1,775

a Prices for Continental USA only.

b Prices effective with initial system purchase. Retrofit prices slightly higher. Contact TENNELEC.

5" AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

Price

LB 5500 FIVE INCH AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

including.....

* Gas Flow Proportional Sample Detector
* Gas Flow Proportional Cosmic Guard Detector
* Lead Shielding and Detector Drawer Assembly
* Electronics and Cabinets
* LB 5120 Microprocessor Controller
* Time of Day/Time of Year Clock
* Dual RS-232-C I/O Ports
* Memory with Battery Back-up
* Remote HV Bias Control
* Five Inch Fifty Sample Automatic Sample Changer
* Set of Sample Carriers with Inserts (specify size)
* Gas Regulator, Flow Meter and Tubing
* Video Terminal and Printer
* Installation and Performance Verification[a]
* One Year On-Site Warranty[a]

LB 5500-3080	Automatic System with 3.25" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 5" diameter samples.	$33,350
LB 5500-3500	Automatic System with 3.25" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 5" diameter samples.	$33,250
LB 5500-5080	Automatic System with 5.0" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 5" diameter samples.	$33,500
LB 5500-5500	Automatic System with 5.0" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 5" diameter samples.	$33,400

LB 5500 OPTIONS

* LBA-11 IBM PC Disk File Conversion Program	$ 125
* LB 5120-01 Single Drive 5¼" Floppy Disk	$ 1,095
* LB 5120-02 Dual Drive 5¼" Floppy Disk	$ 1,775

LB 5500 ACCESSORIES

* 50 Sample Carriers, coded 1-50	P/N 1750-0038	$ 300
* Five Inch Stainless Steel Sample Carrier Inserts:		
3" x 1/8 " (3.072" ID)	P/N 6200-0118	$ 10
3" x 1/4"	P/N 6200-0119	$ 10
3" x 5/16"	P/N 6200-0120	$ 10
4" x 1/8" (4.412" ID)	P/N 6200-0115	$ 11
4" x 1/4"	P/N 6200-0116	$ 11
4" x 5/16"	P/N 6200-0117	$ 11
5" x 1/8" (5.082" ID)	P/N 6200-0121	$ 12
5" x 1/4"	P/N 6200-0122	$ 12
5" x 1/16"	P/N 6200-0123	$ 12

Note: Insert depths are measured from top of carrier to bottom of insert.

a Prices for Continental USA only.

2" AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEMS

		Price
LB 5100 SERIES ACCESSORIES		
* 50 Sample Carriers, BCD coded 1-50	P/N 6200-0096	$ 125
or BCD coded 51-100	P/N 6200-0097	
or BCD coded 101-150	P/N 6200-0088 (except Series I)	
* Sample Carrier Cassette (holds 50 carriers)	P/N 1750-0023	$ 125
* Stainless Steel Sample Carrier Inserts:		
2" x 1/16"	P/N 6200-0012 (Set of 50)	$ 35
2" x 1/8"	P/N 6200-0013 (Set of 50)	$ 40
2" x 1/4"	P/N 6200-0014 (Set of 50)	$ 45
2" x 5/16"	P/N 6200-0009 (Set of 50)	$ 50
1" x 1/16"	P/N 6200-0021 (Set of 50)	$ 35
1" x 1/8"	P/N 6200-0022 (Set of 50)	$ 40
1" x 1/4"	P/N 6200-0023 (Set of 50)	$ 45
1" x 5/16"	P/N 6200-0024 (Set of 50)	$ 50
* Stainless Steel Planchets		
1.00" x 1/8" Planchets	P/N 6200-0010 (Set of 50)	$ 5
2.00" x 1/8" Planchets	P/N 6200-0011 (Set of 50)	$ 15
* Detector Assemblies		
LBG 25 25 inch² guard for 1.25" and 2.25" sample detectors		$ 795
LBD 1500 1.25" diameter sample detector with 500 μgm/cm² Window		$ 1,155
LBD 1080 1.25" diameter sample detector with 80 μgm/cm² Window		$ 1,230
LBD 2500 2.25" diameter sample detector with 500 μgm/cm² Window		$ 1,455
LBD 2080 2.25" diameter sample detector with 80 μgm/cm² Window		$ 1,555
P/N 6200-0065 2.0" diameter CaF(Eu)/NaI(Tl) Phoswich detector assembly		$ 2,250
* Replacement Windows:		
1.25", 500 μgm/cm²	P/N 6200-0035	$ 200
1.25", 80 μgm/cm²	P/N 6200-0036	$ 275
2.25", 500 μgm/cm²	P/N 6200-0037	$ 215
2.25", 80 μgm/cm²	P/N 6200-0038	$ 315
* Printer Paper, pinfeed, box of 3500 11" x 8½" sheets	P/N 6200-0091	$ 50
* Printer Ribbon (Series I Systems)	P/N 6200-0092	$ 10
* Printer Ribbon (Series II Systems)	P/N 6200-0073	$ 5
* Flexible 5¼" Disks, box of 10	P/N 6200-0072	$ 55
* Spare Filter Cartridge (for FM40A)	P/N 6200-0047	$ 65
* Gas Tubing (50 feet)	P/N 6100-0031	$ 25
* Low Background System Test Sources (2" diameter)		
LB-14 Carbon-14		
0.155 MeV Beta, nominal activity 30,000 dpm		$ 250
LB-90 Strontium-90/Yttrium-90		
0.55 and 2.7 MeV Betas, nominal activity 30,000 dpm		$ 250
LB-137 Cesium-137		
0.52 MeV Beta, nominal activity 30,000 dpm		$ 250
LB-210 Polonium-210		
5.3 MeV Alpha, nominal activity 30,000 dpm		$ 350

NOTE: These sources do not require a license

2" AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEMS

Price

LB 5100 SERIES II AUTOMATIC LOW BACKGROUND ALPHA/BETA/GAMMA COUNTING SYSTEM

including.....

* Gas Flow Proportional Sample Detector
* Gas Flow Proportional Cosmic Guard Detector
* Lead Shielding and Detector Drawer Assembly
* Electronics and Cabinets
* LB 5120 Microprocessor Controller
* Time of Day/Time of Year Clock
* Dual RS-232-C I/O Ports
* Memory with Battery Back-up
* Remote HV Bias Control
* Fifty Sample Automatic Sample Changer
* Set of Sample Carriers with 1/8" and 5/16" Inserts
* Gas Regulator, FM40A Flow Meter and Tubing
* Video Terminal and Printer
* Installation and Performance Verification[a]
* One Year On-Site Warranty[a]

LB 5100-1080-II	Series II Automatic System with 1.25" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$28,175
LB 5100-1500-II	Series II Automatic System with 1.25" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$28,100
LB 5100-2080-II	Series II Automatic System with 2.25" diameter sample detector and 80 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$28,500
LB 5100-2500-II	Series II Automatic System with 2.25" diameter sample detector and 500 μgm/cm^2 window. Sample changer handles up to 2" diameter samples.	$28,400

LB 5100 SERIES II OPTIONS

* LBA-01 Mobile Cabinet	$ 2,850[b]
* LBA-03 100 Sample Capacity (includes additional carriers and inserts)	$ 595[b]
* LBA-07 Gamma Detector option	$ 2,750[b]
* LBA-08 MCA Synchronization	$ 250[b]
* LBA-11 IBM PC Disk File Conversion Program	$ 125
* LB 5120-01 Single Drive 5¼" Floppy Disk	$ 1,095
* LB 5120-02 Dual Drive 5¼" Floppy Disk	$ 1,775

a Prices for Continental USA only.

b Prices effective with initial system purchase. Retrofit prices slightly higher. Contact TENNELEC.

5" AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

LB 5500 ACCESSORIES CON'T		Price
* Detector Assemblies		
LBG 100 100 inch² guard for 3.25" and 5.0" sample detectors		$ 1,500
LBD 3500 3.25" diameter sample detector with 500 μgm/cm² Window		$ 2,050
LBD 3080 3.25" diameter sample detector with 80 μgm/cm² Window		$ 2,150
LBD 5500 5.0" diameter sample detector with 500 μgm/cm² Window		$ 2,200
LBD 5080 5.0" diameter sample detector with 80 μgm/cm² Window		$ 2,300
* Replacement Windows for gas flow detectors:		
3.25", 500 μgm/cm²	P/N 6200-0039	$ 425
3.25", 80 μgm/cm²	P/N 6200-0040	$ 525
5.0", 500 μgm/cm²	P/N 6200-0041	$ 475
5.0", 80 μgm/cm²	P/N 6200-0042	$ 575
* Printer Paper, pinfeed, box of 3500 11" x 8½" sheets	P/N 6200-0091	$ 50
* Printer Ribbon	P/N 6200-0073	$ 5
* Flexible 5¼" Disks, box of 10	P/N 6200-0072	$ 55
* Spare Filter Cartridge (for FM40A)	P/N 6200-0047	$ 65
* Gas Tubing (50 feet)	P/N 6100-0031	$ 25
* Low Background System Test Sources (2" diameter)		
LB-14 Carbon-14		
0.155 MeV Beta, nominal activity 30,000 dpm		$ 250
LB-90 Strontium-90/Yttrium-90		
0.55 and 2.7 MeV Betas, nominal activity 30,000 dpm		$ 250
LB-137 Cesium-137		
0.52 MeV Beta, nominal activity 30,000 dpm		$ 250
LB-210 Polonium-210		
5.3 MeV Alpha, nominal activity 30,000 dpm		$ 350

NOTE: These sources do not require a license

MANUAL PLANCHET COUNTING SYSTEMS

	Price
MPC-175GM MANUAL PLANCHET COUNTING SYSTEM	$ 3,950

including.....
* 1.75" diameter GM Detector
* Sample Stand with Lead Shield
* Preamplifier, TC 908 HV Bias Supply, TC 534 Counter/Timer
* MB2/TC 910 NIM Bin & Power Supply
* Set of Sample Carriers with 1/8" and 5/16" Deep Inserts

MPC OPTIONS AND ACCESSORIES	
* TC 576 Buffered Printer	$ 1,495
* TC 576-01 Pack of 3 rolls of paper for TC 576	$ 15
* TC 566A Time of Day/Time of Year Clock	$ 790
* P/N 6200-0113 Spare 1.75" Diameter G-M Detector	$ 250

AUTOMATIC PLANCHET COUNTING SYSTEMS

		Price
APC-175GM AUTOMATIC PLANCHET COUNTING SYSTEM		$15,400

including.....

* 1.75" diameter GM Detector
* Lead Shield
* Electronics and Cabinets
* LB 5111 Microprocessor Controller
* Time of Day/Time of Year Clock
* RS-232-C Data Only Output Port
* Fifty Sample Automatic Sample Changer
* Set of Sample Carriers with 1/8" and 5/16" Deep Inserts
* KSR 43 Terminal/Printer
* Installation and Performance Verification[a]

APC OPTIONS AND ACCESSORIES

* LBA-03 100 Sample Capacity (includes additional carriers and inserts)		$ 595[b]
* 50 Sample Carriers, BCD coded 1-50	P/N 6200-0096	$ 125
or BCD coded 51-100	P/N 6200-0097	
* Sample Carrier Cassette (holds 50 carriers)	P/N 1750-0023	$ 125
* Stainless Steel Sample Carrier Inserts:		
2" x 1/16"	P/N 6200-0012 (Set of 50)	$ 35
2" x 1/8"	P/N 6200-0013 (Set of 50)	$ 40
2" x 1/4"	P/N 6200-0014 (Set of 50)	$ 45
2" x 5/16"	P/N 6200-0009 (Set of 50)	$ 50
1" x 1/16"	P/N 6200-0021 (Set of 50)	$ 35
1" x 1/8"	P/N 6200-0022 (Set of 50)	$ 40
1" x 1/4"	P/N 6200-0023 (Set of 50)	$ 45
1" x 5/16"	P/N 6200-0024 (Set of 50)	$ 50
* Stainless Steel Planchets		
1.00" x 1/8" Planchets	P/N 6200-0010 (Set of 50)	$ 5
2.00" x 1/8" Planchets	P/N 6200-0011 (Set of 50)	$ 15
* Spare 1.75" Diameter G-M Detector	P/N 6200-0113	$ 250
* Printer Paper, pinfeed, box of 3500 11" x 8½" sheets	P/N 6200-0091	$ 50
* Printer Ribbon	P/N 6200-0092	$ 10
* System Test Sources (2" diameter)		
LB-90 Strontium-90/Yttrium-90 0.55 and 2.7 MeV Betas, nominal activity 30,000 dpm		$ 250
LB-137 Cesium-137 0.52 MeV Beta, nominal activity 30,000 dpm		$ 250
LB-210 Polonium-210 5.3 MeV Alpha, nominal activity 30,000 dpm		$ 350

NOTE: These sources do not require a license

a Prices for Continental USA only.
b Prices effective with initial system purchase. Retrofit prices slightly higher. Contact TENNELEC.

Shipping Methods: We normally ship by Motor Freight or UPS. Other shipping methods will be followed at your request.

Warranty: TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices: All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

TENNELEC - A Quarter Century of Service

Founded in 1960 by Edward Fairstein, one of the world's leading designers and authors in the nuclear electronics field, Tennelec has always developed and provided the highest performance, most reliable instrumentation for your nuclear research. Your continuing trust and confidence in us has made this possible.

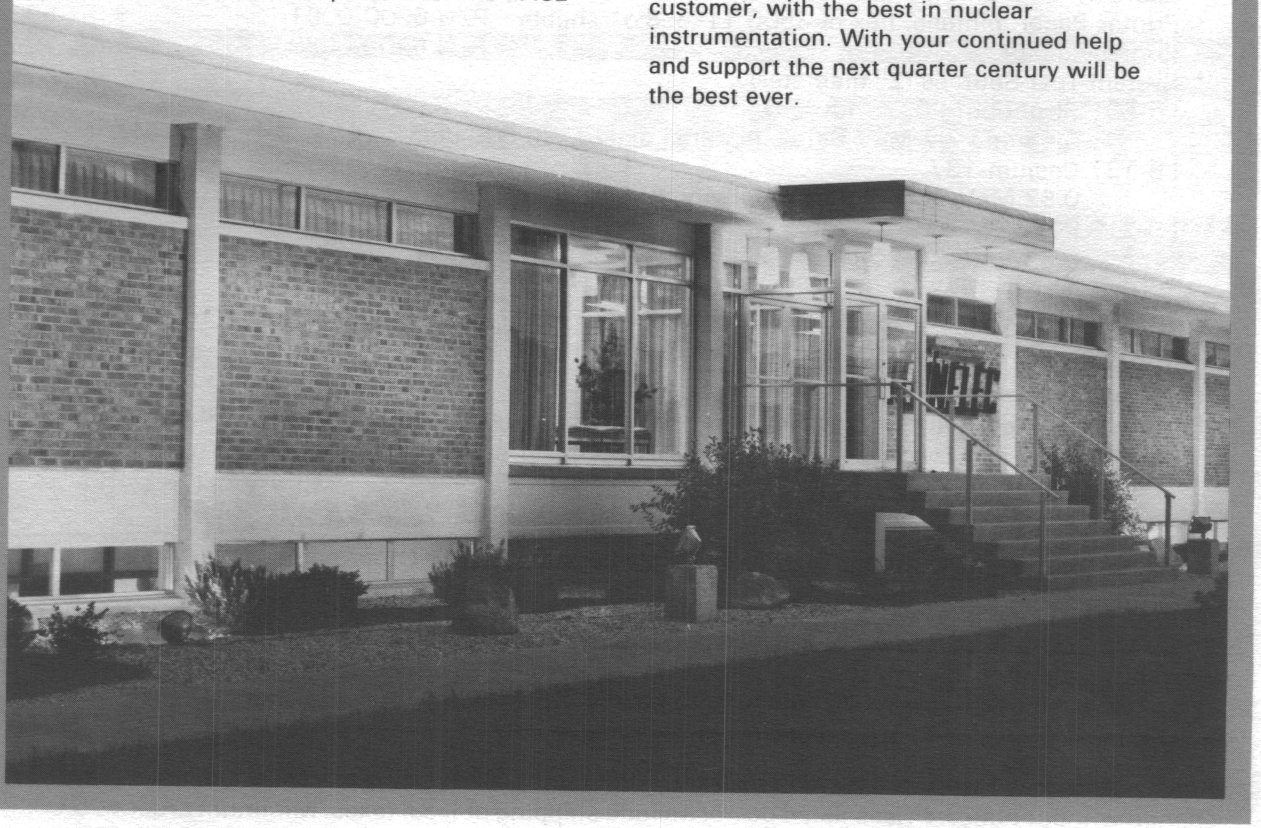
In the early 1960's Tennelec set the standards of performance by designing and manufacturing the very first ultra low-noise charge-sensitive preamplifier for silicon semiconductor detectors. In 1964, with the advent of advanced transistor technology, Tennelec designed and manufactured the model TC 200 linear amplifier. The TC 200, using an "active element" pulse shaping technique, represented a radical departure from contemporary linear amplifiers. Built to Tennelec's most stringent requirements for performance and reliability, the TC 200 quickly became the worldwide laboratory standard, with many still in productive use today.

The Pulsed Analog-to-Digital Converter and Encoding (PACE) System used a patented series-parallel encoding technique that enabled it to digitize up to 8192 channels of data in less than 4.5 μ seconds. The PACE System was the forerunner of today's fast analog-to-digital converters whose speed is only now rivaling their Tennelec predecessor.

The 1970's were a period of diversification and realignment for Tennelec. After a brief venture into the commercial products marketplace, Tennelec realized that its real strength was in nuclear instrumentation. Revitalized with new managerial talent, Tennelec focused on its old marketplace and laid the groundwork to emerge as a leader in the next decade.

In 1982, Tennelec acquired the technology to manufacture silicon surface barrier detectors. The next year, Tennelec purchased the high purity germanium crystal growing facility of a major corporation and moved the entire division to its headquarters in Oak Ridge, Tennessee. Here, a new 9,000 square foot building houses both divisions of the semiconductor manufacturing facility.

Now, in 1985, we ask you to celebrate our silver anniversary with us. We also want to express our sincere thanks to each of our loyal customers because we realize that without you, none of this would have been possible. In 1985, all of us at Tennelec rededicate ourselves to providing you, our customer, with the best in nuclear instrumentation. With your continued help and support the next quarter century will be the best ever.



TENNELEC INC. 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA

PHONE 615-483-8405 TWX 810-572-1018

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TENNELEC, INC.

June 1986

PRICE LIST
DOMESTIC

CP SERIES
HIGH-PURITY COAXIAL
P-TYPE GERMANIUM DETECTOR SYSTEMS

Efficiency %	Resolution 1.332 Mev (keV)	Resolution 122 keV (eV)	P/C Ratio	FWTM/FWHM Ratio	PRICE (U.S. $)
10	1.75	825	41:1	1.90	9,550.00
10	1.85	900	39:1	1.95	9,125.00
10	1.95	1000	37:1	2.00	8,910.00
15	1.80	825	46:1	1.90	11,920.00
15	1.90	900	44:1	1.95	11,600.00
15	2.00	1000	41:1	2.00	11,075.00
20	1.80	850	51:1	1.90	14,390.00
20	1.90	925	48:1	1.95	13,865.00
20	2.00	1100	46:1	2.00	13,340.00
25	1.85	850	55:1	1.90	17,995.00
25	1.95	925	52:1	1.95	16,955.00
25	2.10	1100	48:1	2.00	16,430.00
30	1.85	875	58:1	1.90	20,055.00
30	1.95	950	56:1	1.95	19,015.00
30	2.10	1200	52:1	2.00	17,460.00

NOTE: Prices shown are for the VDS (vertical dipstick) cryostat and 30 liter dewar. Add $250.00 for the HDS (horizontal dipstick) cryostat.

Shipping Methods: Tennelec normally ships by Air Freight. Other shipping methods will be followed at your request.

Warranty: TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices: All prices listed herein are in U.S. currency, F.O.B. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes.

Payment Terms: 1% 10, Net 30 days.

Date:

Price: 10
Order:

To: Mr. Monger
High Quality Cleaning
Hoover Cleaning Company Address

Efficiency	Resolution 1.332 Mev (Kev)	Resolution 122 Kev (Ev)	Price Each	Price Total (US $)
5	1.75	850	1.90	9,550.00
7	1.80	700	1.95	9,650.00
10	1.85	600	2.00	9,900.00
15	1.90	675	1.80	11,920.00
15	1.90	500	1.95	12,700.00
15	2.00	1000	2.00	12,900.00
20	1.80	550	1.90	14,190.00
20	1.90	575	1.95	15,095.00
20	2.00	1100	2.00	15,340.00
25	1.85	550	1.90	17,955.00
25	1.95	625	1.95	18,555.00
25	2.10	1100	2.00	18,420.00
30	1.85	575	1.90	20,055.00
30	1.95	650	1.95	20,615.00
30	2.10	1200	2.00	21,480.00

NOTE: Prices shown are for the TCS (cylindrical geometry) cryostat and 10 liter dewar. Add $2,000.00 for the HBS (horizontal objective) cryostat.

Shipping Methods: Tennelec normally ships by Air Freight. Other shipping methods will be followed at your request.

Warranty: TENNELEC products are designed and manufactured to meet quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC that originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Terms: All prices listed herein are in U.S. currency, F.O.B. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes.

Payment Terms: 1%-10, Net 30 days.

TENNELEC, INC.

LB Systems for the Personal Computer

DOMESTIC

LB 5100 SERIES II SYSTEMS

LB 5100-1080-II-PC	$26,675
LB 5100-1500-II-PC	$26,600
LB 5100-2080-II-PC	$27,000
LB 5100-2500-II-PC	$26,900

LB 5100 SERIES III SYSTEMS

LB 5100-1080-III-PC	$26,675
LB 5100-1500-III-PC	$26,600
LB 5100-2080-III-PC	$27,000
LB 5100-2500-III-PC	$26,900

LB 5100 PHOSWICH SYSTEM

LB 5100-PW-PC	$27,000

LB 5500 FIVE INCH SYSTEMS

LB 5500-3080-PC	$31,850
LB 5500-3500-PC	$31,750
LB 5500-5080-PC	$32,000
LB 5500-5500-PC	$31,900

UPGRADE OPTION

LBA-12 PERSONAL COMPUTER COMMUNICATIONS KIT $175

PERSONAL COMPUTER OPTIONS

IBM-PC $3,750
(256K, DUAL FLOPPIES, MONOCHROME MONITOR, PRINTER)

IBM-XT $5,350
(256K, ONE FLOPPY, 20MB HARD DISK, MONOCHROME MONITOR, PRINTER)

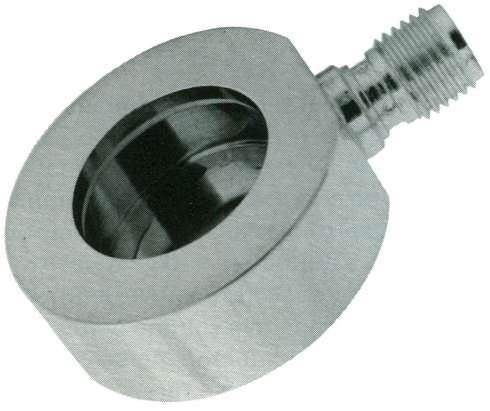
IBM-AT $7,250
(512K, ONE FLOPPY, 20MB HARD DISK, MONOCHROME MONITOR, PRINTER)

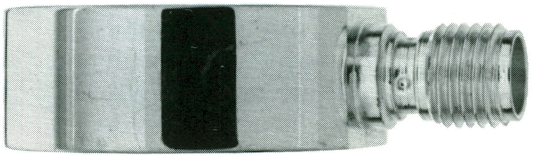
COLOR MONITOR ADD $485

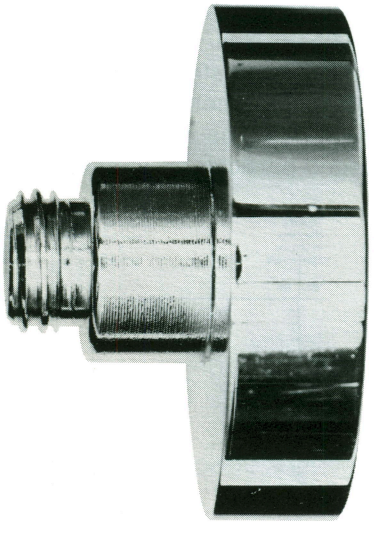
TENNELEC

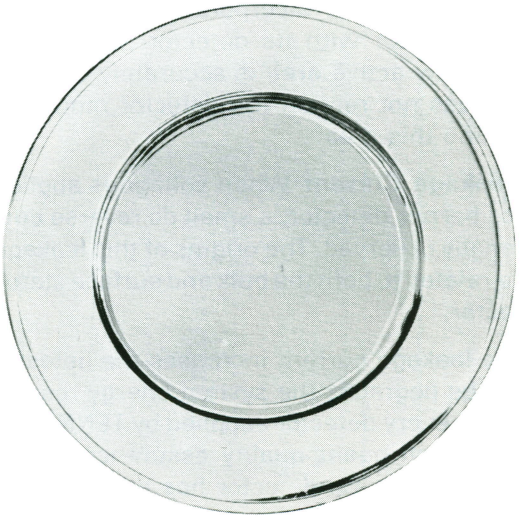
Selection Guide and Price List

Silicon Charged Particle Detectors









TENNELEC **Silicon Charged Particle Detectors** are available in several active areas from 25 mm^2 to 2000 mm^2, sensitive depths from 40 microns to greater than 1000 microns and in extremely compact, Slimline™ housings to provide the research and industrial spectroscopist with the correct detector for nearly any application.

TENNELEC's comprehensive line of detectors consists of eight (8) series.

- **PD Series** — Partially Depleted
- **PP Series** — Premium Partially Depleted
- **CE Series** — Cleanable Front Electrode
- **TD Series** — Transmission Detector
- **TP Series** — Transmission Planar
- **HI Series** — Heavy Ion
- **HE Series** — Harmful Environment
- **CAM Series** — Continuous Air Monitor

Introduction

TENNELEC Silicon Charged Particle Detectors are surface barrier detectors made of high quality, single crystal silicon utilizing state-of-the-art technology.

Surface barrier detectors for charged particle spectroscopy have wide application in physics and nuclear chemistry. They can be used to detect and analyze charged particles over a broad range of energies with essentially 100% efficiency for their active volume.

A detector's active volume is created by an electric field applied across the detector's contacts. This electric field sweeps the region between the detector contacts free of charge carriers. Incoming charged particles enter this charge-free region through a thin, insensitive window of gold or aluminum. Through electromagnetic and electrostatic (Coulomb) interaction, the charged particle's energy is transferred to the detector, creating electron-hole pairs. These electron-hole pairs are then swept clear of the depleted, sensitive region and collected on the oppositely-charged electrodes (detector contacts). The integrated charge collected is proportional to the energy lost by the incident charged particle.

Operational Characteristics

Area The active area of the detector selected for any application is very important as it affects both the counting efficiency and energy resolution of the system. These two parameters are in conflict with one another. A larger active area detector will always be more efficient, however, a smaller active area detector will have a lower capacitance and thus provide better energy resolution.

Selecting the correct detector area for an application often requires a compromise between counting efficiency and energy resolution.

Collimation TENNELEC incorporates a precisely machined collimator with its detector so that the entrance window active area is accurately defined. TENNELEC does not rely on the detector mounting epoxy to define this area.

Reverse Leakage Current When voltage is applied to a surface barrier detector, a small dc reverse current is normally observed. The origins of this leakage current are related to both the bulk and surface states of the detector.

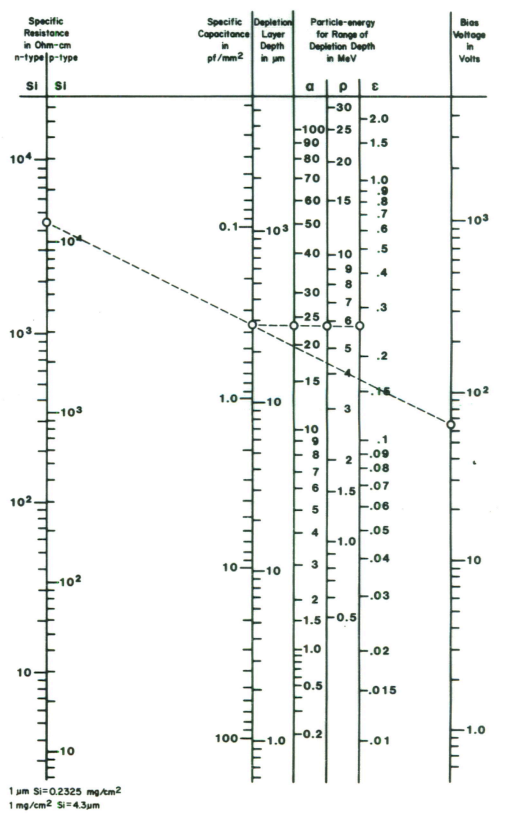
This reverse leakage current increases the detector noise and thus degrades the system energy resolution. Each and every detector supplied by TENNELEC is subjected to stringent quality assurance procedures to assure that no detector has an excessive leakage current.

Bias Voltage Compensation The bias voltage to the detector is always supplied through a series resistor found in the preamplifier for signal isolation. There is a voltage drop across this resistor equal to the product of the leakage current and the series resistor. The bias voltage must be modified upwards to compensate for this drop.

$$V_d = V_a - (I_l \times R_s)$$

V_d = True detector voltage
V_a = Voltage applied
I_l = Detector leakage current
R_s = Preamplifier bias resistor.

Sensitive Depth For charged particle spectroscopy and most other applications, the detector's sensitive depth must be sufficient to completely absorb all of the incident particle's energy. The pulse amplitude generated will then be proportional to the total energy of the charged particle being analyzed. As this sensitive depth increases, the detector capacitance decreases resulting in a decrease in preamplifier noise. This increase in sensitive depth, however, also increases the sensitive volume of the detector which may increase the detectors noise contribution. Sensitive depth, like active area, must be carefully selected to optimize the detector system performance. The nomogram below is similar to the one originally published by J. L. Blankenship, IREE Trans. Vol. NS-7, Nos. 2-3, pp 190-195, June 1960. This nomogram illustrates, among other things, the relationship between sensitive depth, active area and capacitance, as well as the range in silicon for charged particles of varying energies.



Capacitance The major effect of detector capacitance on system performance is its influence on the noise generated by the preamplifier. Additionally, detector capacitance affects the rise time of the preamplifier. Two ways to minimize detector capacitance are to restrict the active area and/or to increase the sensitive depth. In general, a factor of 10 increase in sensitive depth will result in a 10 fold decrease in capacitance in picofarads per mm^2 of active area. For example: 100 μ deep has 1 pf/mm^2; 1000 μ deep has 0.1 pf/mm^2.

Noise and Energy Resolution† There are three major sources of noise in a silicon surface barrier detector.

1. Bulk leakage current
2. Surface leakage current
3. Johnson noise

These noise sources result in spectral peak broadening and therefore a degradation of resolution. These noise sources add in quadrature, so that;

$$(\Delta E_{noise})^2 = (\Delta E_{bulk})^2 + (\Delta E_{surface})^2 + (\Delta E_{Johnson})^2$$

where ΔE represents the peak broadening due to each noise source.

Entrance Window Thickness A charged particle entering a detector must pass through an insensitive region, entrance window, before reaching the active volume of the detector. In passing through this window, an amount of energy will be lost as a function of particle size, energy, window thickness and angle of incidence. As this lost energy is a contributor to detector resolution degradation, the entrance window must be as thin as possible and yet thick enough so as not to compromise good electrical contact.

The entrance window for the TENNELEC PD, PP, TD, TP and HI Series detector is $\leq$40 μgms/cm^2 gold, which is nominally equivalent to 800 angstroms of silicon. Total dead layer does not exceed 20 keV energy loss for 5.486 MeV alpha particles. The exit window of the TD and TP Series detectors is $\leq$40 μgms/cm^2 aluminum, which is nominally equivalent to 2250 angstroms of silicon. The entrance window of the CE Series is $\leq$50 μgms/cm^2 aluminum, which is nominally equivalent to 2300 angstroms of silicon. Contact TENNELEC for light tight or other special entrance window requirements.

CAM-500 and HE Series detectors are usually operated in the counting mode. Entrance window thickness is of minimal concern for this mode of use. Maximum energy loss through these windows is <120 keV for 5.486 MeV alpha particles.

The TENNELEC Detector

TENNELEC offers a complete line of Slimline™ detectors featuring low background, increased area, improved geometry, improved resolution and superior timing performance.

Low Background All TENNELEC detectors are specially manufactured and packaged to minimize background problems. TENNELEC accomplishes this through the use of smaller mounting components and using materials which have virtually no naturally occurring radionuclide contaminates.

Increased Area The Slimline™ package does not rob active area from the silicon wafer.

Improved Geometry The Slimline™ design places the detector front electrode less than 1 mm from the front surface of the housing (less than 0.5 mm for unmounted detectors). This means that oblique entry angles are essentially unshadowed by the external package. The housings are thinner than other detectors. This allows larger detectors to be placed into smaller counting chambers and transmission mount detectors can be stacked more closely together.

Improved Resolution Because of our new MIS technology, the Slimline™ detector has lower noise and better energy resolution. This MIS technology reduces the thickness of the silicon oxide layer which reduces the noise and improves the energy resolution.

Superior Timing The Slimline™ detector mount uses no coil springs. Thus, a major inductive component is eliminated from the signal path and thus improves risetime performance to further enhance timing performance.

Detector Description

Partially Depleted (PD) Series detectors are available in a wide range of active areas from 25 mm^2 to 1000 mm^2, and sensitive depths from 100 microns to 1000 microns. (See Table 1). Other sensitive depths and areas are available on special request.

Premium Partially Depleted (PP) Series detectors are the best of the best PD Series detectors and are available in a wide range of active areas from 25 mm^2 to 500 mm^2 and sensitive depths from 100 microns to 500 microns. See Table 2 for a complete selection of available detectors.

Cleanable Front Electrode (CE) Series detectors have a rugged, cleanable aluminum entrance window. These detectors are available in several active areas from 50 mm^2 to 2000 mm^2 and sensitive depths from 100 microns to 1000 microns (See Table 3). Other areas and depletion depths are available on special request.

† From Glenn F. Knoll, "Radiation Detection and Measurement", John Wiley & Sons, New York, 1979, Chapter 11.

Transmission Detector (TD) Series spectrometers are sensitive through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are typically used in ΔE and timing experiments and are offered in a variety of active areas and thicknesses, from 25 mm^2 to 500 mm^2 and 150 microns to 1000 microns (See Table 4). Other thicknesses and areas are available on special request.

All TD Series detectors are cut off-axis from the original crystal to minimize particle channeling. Specified alpha resolutions for detectors <500 microns thick are for 5.486 MeV alpha particles incident through the rear (low field) electrode.

Transmission Planar (TP) Series detectors are totally depleted through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are specially processed for the ultimate in planarity and thickness uniformity across the entire active area. Detectors are available in thicknesses from 40 microns to 100 microns and active areas from 25 mm^2 to 300 mm^2 (See Table 5). Other thicknesses and areas available on special request.

Heavy Ion (HI) Series detectors are partially depleted to a sensitive depth of ≥60 microns and manufactured from silicon with characteristics that withstand extremely high electric field strengths (≥15,000 volts/cm at the entrance window) without introducing surface multiplication effects. Active areas from 100 mm^2 to 1000 mm^2 are available (See Table 6) with other areas available on special request. All HI series detectors are cut off-axis to minimize channeling and come in a close mount (<0.040") configuration. Second category devices with a slightly lower field strength are offered.

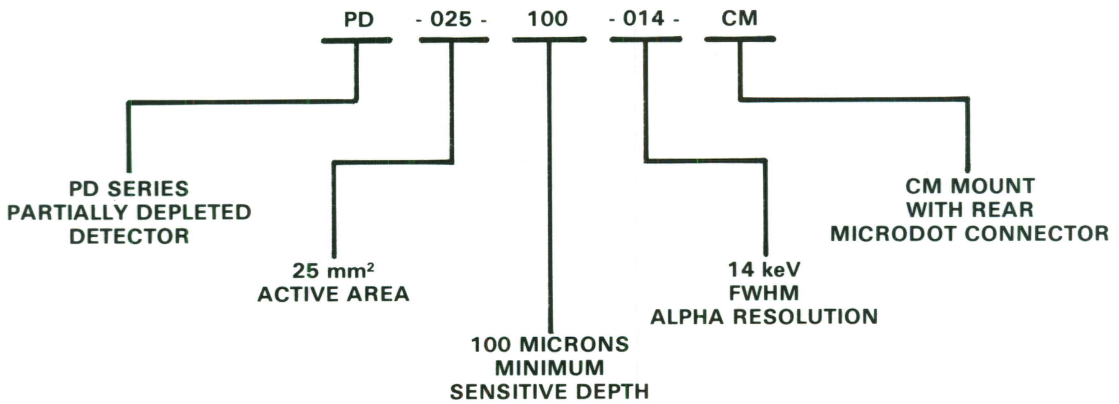
CAM 500 Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors (CAMs). These detectors are resistant to ambient light and cleanable. CAM 500 Series detectors have a 500 mm^2 nominal active area and come in two standard models configured for your mounting needs, the CAM 500B with a rear-mounted female BNC connector and the CAM 500M with a rear-mounted female microdot connector (See Table 7). Other configurations can be supplied on special request.

Harmful Environment (HE) Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors under harmful corrosive gas conditions. The HE 500 Series detectors are configured in the same manner as the CAM 500 Series detectors. In addition, the HE 500 Series are specially treated with a corrosion-resistant polymer coating over the front gold electrode. This dramatically extends the useable lifetime of this detector under corrosive gas conditions, such as hydrofluoric acid. (See Table 8). Other configurations can be supplied on special request.

General Information

Model Number

The TENNELEC model number fully defines the physical and performance specifications of the detector.



Alpha Resolution is warranted as the full peak width at one-half the maximum peak height (Full Width at Half Maximum, FWHM) expressed in keV for Americium - 241, 5.486 MeV alphas. The actual measured resolution will be better than the warranted resolution. Specifications are based on measurements made with standard TENNELEC electronics and an electroplated alpha source and include the electronic noise contribution of the preamplifier.

Beta Resolution is approximately the noise width measured at the FWHM expressed in keV for an electronic pulser peak. Measurements are made with standard TENNELEC electronics and include the electronic noise contribution of the preamplifier.

Collimation Slimline™ detectors are designed so that special collimators can be located to within 1 mm (0.040") of the detector entrance window. Internally mounted collimators can be located to within 0.5 mm (0.020") of the entrance window. For more information on collimators, contact the factory.

Mount Types

TENNELEC Silicon charged particle detectors are available in five (5) standard mount types.

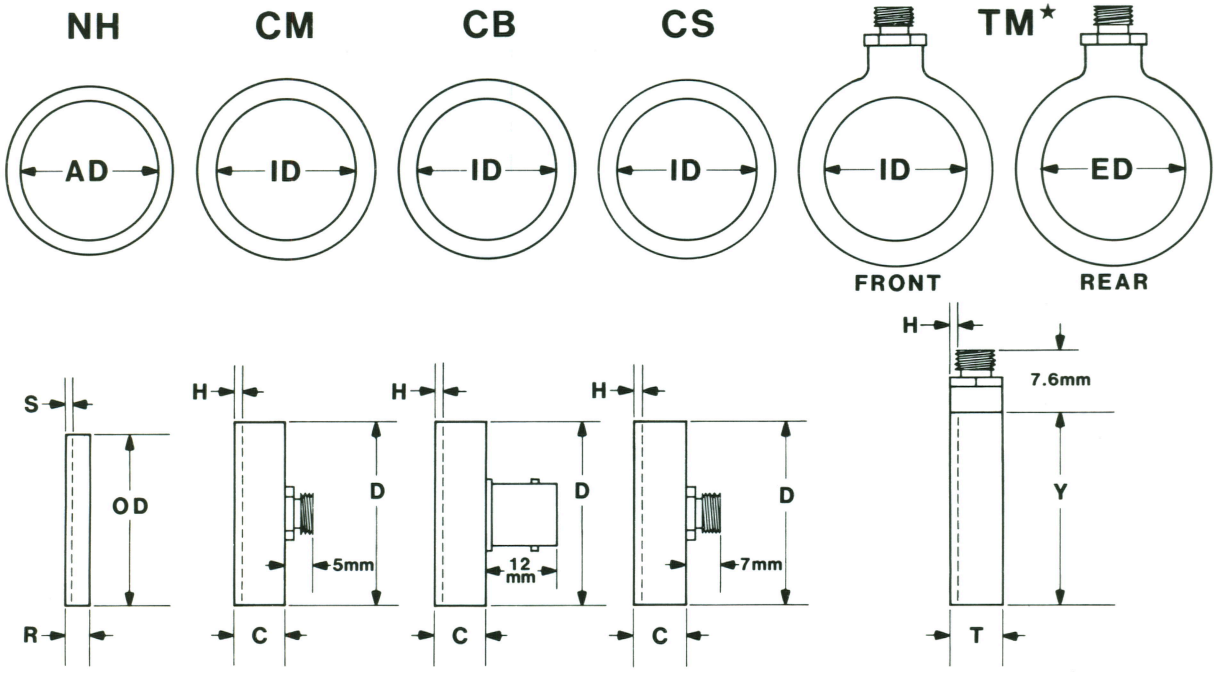
Mount Type	Description
CB	Rear BNC connector
CM	Rear Microdot connector
CS	Rear SMA connector
NH	No housing
TM	Transmission, side microdot connector
TS	Transmission, side SMA connector

mount types are available on special request.

Specifications and Definitions Standards

All TENNELEC specifications and definitions of terms comply with the latest revisions of IEEE/ANSI 300 and IEC 333. Warranted performance is for operation in vacuum at 20°C at the amplifier peaking time (T_p) shown. For modern, high performance amplifiers, T_p is approximately two (2) times the shaping time constant.

Mount Dimensions



Active Area (mm^2)	Active Diameter A.D.±0.2 I.D.†± 0.0/0.2 mm	Exit Opening E.D.±0.1 mm	Outside Diameter ±0.3 mm		
			OD	D	Y
25	5.6	6.9	12.7	16.6	15.1
50	8.0	9.3	14.6	16.6	18.3
100	11.3	12.6	18.4	23.0	20.8
150	13.8	15.1	20.9	23.0	24.9
200	16.0	17.6	23.0	28.4	25.0
300	19.6	20.8	26.2	28.4	28.5
400	22.6	23.8	29.6	32.0	32.0
500	25.3	26.5	32.2	34.3	34.7
600	27.6	28.9	34.1	36.0	37.3
1000	35.7	37.0	43.1	45.2	47.0
2000	50.5	—	59.6	60.9	—

Active Depth (μm)	Front Surface To Det. Spacing ±0.1 mm		Detector Thickness ±0.3 mm		
	S	H	R	C	T
0-600	0.5	1.0	1.5	9.0	7.6
601-1100	1.0	1.6	3.0	12.6	10.0
1200-2100	1.3	1.9	4.6	12.6	12.6

★ SMA connector on transmission type housing available on special order.

† I.D. is provided through a built-in collimator only found with TENNELEC charged particle detectors. This removes the epoxy halo effect and gives you a precise active area.

Table 1. PD Series Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	13	6	PD-25-100-13	170	PD-25-300-13	370	PD-25-500-13	670
	14	6	PD-25-100-14	135	PD-25-300-14	280	PD-25-500-14	510
	15	7			PD-25-300-15	195	PD-25-500-15	405
50	14	7	PD-50-100-14	195	PD-50-300-14	380	PD-50-500-14	720
	15	8	PD-50-100-15	170	PD-50-300-15	290	PD-50-500-15	550
	17	9	PD-50-100-17	145	PD-50-300-17	245	PD-50-500-17	445
100	14	7	PD-100-100-14	300	PD-100-300-14	570	PD-100-500-14	930
	15	8	PD-100-100-15	265	PD-100-300-15	470	PD-100-500-15	770
	16	9	PD-100-100-16	205	PD-100-300-16	365	PD-100-500-16	585
150	15	9	PD-150-100-15	330	PD-150-300-15	610	PD-150-500-15	970
	16	10	PD-150-100-16	285	PD-150-300-16	490	PD-150-500-16	780
	18	12	PD-150-100-18	225	PD-150-300-18	355	PD-150-500-18	625
200	16	10	PD-200-100-16	400	PD-200-300-16	730	PD-200-500-16	1060
	17	11	PD-200-100-17	345	PD-200-300-17	540	PD-200-500-17	860
	19	14	PD-200-100-19	290	PD-200-300-19	395	PD-200-500-19	685
300	17	13	PD-300-100-17	490	PD-300-300-17	800	PD-300-500-17	1180
	18	14	PD-300-100-18	425	PD-300-300-18	660	PD-300-500-18	960
	19	15	PD-300-100-19	335	PD-300-300-19	465	PD-300-500-19	775
400	18	13	PD-400-100-18	540	PD-400-300-18	840	PD-400-500-18	1210
	19	14	PD-400-100-19	440	PD-400-300-19	690	PD-400-500-19	990
	21	16	PD-400-100-21	350	PD-400-300-21	480	PD-400-500-21	795
500	19	14	PD-500-100-19	590	PD-500-300-19	880	PD-500-500-19	1310
	21	16	PD-500-100-21	450	PD-500-300-21	695	PD-500-500-21	1040
	25	20	PD-500-100-25	355	PD-500-300-25	485		
600	22	18	PD-600-100-22	950				
	24	19	PD-600-100-24	565				
1000	39	34	PD-1000-100-39	1205				
	44	39	PD-1000-100-44	955				
>1000			Special Order					

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]PD Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 2. PP Series Premium Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	12	5	PP-25-100-12	405	PP-25-300-12	555	PP-25-500-12	775
50	13	6	PP-50-100-13	465	PP-50-300-13	655	PP-50-500-13	1005
100	13	6	PP-100-100-13	605	PP-100-300-13	855	PP-100-500-13	1155
150	14	8	PP-150-100-14	715	PP-150-300-14	985	PP-150-500-14	1215
200	15	9	PP-200-100-15	745	PP-200-300-15	1085	PP-200-500-15	1345
300	16	12	PP-300-100-16	885	PP-300-300-16	1205	PP-300-500-16	1455
400	17	12	PP-400-100-17	985	PP-400-300-17	1315	PP-400-500-17	1555
500	18	13	PP-500-100-18	1085	PP-500-300-18	1435	PP-500-500-18	1655

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Premium performance guaranteed for 3 months. Best category PD Series performance for equivalent size detector guaranteed for remaining 9 months of one (1) year guarantee.

[3]PP Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 1. PD Series Continued

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Min Sensitive Depth 1000 μm		Min Sensitive Depth >1000 μm
	α	β	Model No.	Price	Model No.
25	13	6	PD-25-1000-13	1150	Special Order
	14	6	PD-25-1000-14	880	
	15	7	PD-25-1000-15	675	
50	14	7	PD-50-1000-14	1200	Special Order
	15	8	PD-50-1000-15	930	
	17	9	PD-50-1000-17	775	
100	14	7	PD-100-1000-14	1420	Special Order
	15	8	PD-100-1000-15	1300	
	16	9	PD-100-1000-16	905	
150	15	9	PD-150-1000-15	1580	Special Order
	16	10	PD-150-1000-16	1340	
	18	12	PD-150-1000-18	1265	
200	16	10	PD-200-1000-16	1690	Special Order
	17	11	PD-200-1000-17	1570	
	19	14	PD-200-1000-19	1475	
300	17	13	PD-300-1000-17	1850	
	18	14	PD-300-1000-18	1740	
	19	15			
400	18	13	PD-400-1000-18	2390	
	19	14	PD-400-1000-19	2030	

Table 3. CE Series Cleanable Front Electrode Detectors.

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 100 μm	
	α	β	Model No.	Price
50	15	7	CE-50-100-15	405
	17	8	CE-50-100-17	325
100	16	10	CE-100-100-16	445
	18	11	CE-100-100-18	365
150	16	10	CE-150-100-16	495
	19	11	CE-150-100-19	405
300	19	13	CE-300-100-19	825
	21	15	CE-300-100-21	645
400	22	17	CE-400-100-22	870
	24	19	CE-400-100-24	690
500	23	18	CE-500-100-23	915
	26	20	CE-500-100-26	740
600	25	19	CE-600-100-25	1165
	33	28	CE-600-100-33	995
1000	33	28	CE-1000-100-33	1550
	40	35	CE-1000-100-40	1430
2000	50	40	CE-2000-100-50	2595
	60	55	CE-2000-100-60	2395

Table 3. CE Series Continued

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 300 μm		Minimum Sensitive Depth 500 μm		Guaranteed Max Resolution (keV)[1]		Minimum-Sensitive Depth 1000 μm	
	α	β	Model No.	Price	Model No.	Price	α	β	Model No.	Price
50	15	7	CE-50-300-15	655	CE-50-500-15	995	17	10	CE-50-1000-17	1725
	17	8	CE-50-300-17	475	CE-50-500-17	915				
100	16	10	CE-100-300-16	665	CE-100-500-16	1090	19	12	CE-100-1000-19	1870
	18	11	CE-100-300-18	550	CE-100-500-18	1005				
150	16	10	CE-150-300-16	675	CE-150-500-16	1185	20	13	CE-150-1000-20	2015
	19	11	CE-150-300-19	625	CE-150-500-19	1095				
300	19	13	CE-300-300-19	965	CE-300-500-19	1415	22	17	CE-300-1000-22	2305
	21	15	CE-300-300-21	795	CE-300-500-21	1295				
400	22	17	CE-400-300-22	1100	CE-400-500-22	1515	25	19	CE-400-1000-25	2475
	24	19	CE-400-300-24	895	CE-400-500-24	1365				
500	23	18	CE-500-300-23	1255	CE-500-500-23	1615	26	20	CE-500-1000-26	2625
	26	20	CE-500-300-26	990	CE-500-500-26	1435				
600	25	19	CE-600-300-25	1455	CE-600-500-25	2235	34	30	CE-600-1000-34	Special Order
	33	28	CE-600-300-33	1435	CE-600-500-33	1965				
1000	33	28	CE-1000-300-33	2095	CE-1000-500-33	3235				
	40	35	CE-1000-300-40	1955	CE-1000-500-40	3025				
2000	50	40	CE-2000-300-50	3235	CE-2000-500-50	3810				
	60	55	CE-2000-300-60	3030	CE-2000-500-60	3575				

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]CE Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Transmission Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)							
			150 μm (125-175 μm)		200 μm (176-225 μm)		250 μm (226-275 μm)		300 μm (276-350 μm)	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	15	6	TD-25-150-15	335	TD-25-200-15	355	TD-25-250-15	375	TD-25-300-15	395
	16	7	TD-25-150-16	265	TD-25-200-16	285	TD-25-250-16	305	TD-25-300-16	325
50	15	6	TD-50-150-15	485	TD-50-200-15	505	TD-50-250-15	525	TD-50-300-15	545
	16	7	TD-50-150-16	375	TD-50-200-16	395	TD-50-250-16	415	TD-50-300-16	435
100	16	8	TD-100-150-16	585	TD-100-200-16	615	TD-100-250-16	645	TD-100-300-16	685
	17	9	TD-100-150-17	465	TD-100-200-17	495	TD-100-250-17	515	TD-100-300-17	545
150	17	9	TD-150-150-17	625	TD-150-200-17	675	TD-150-250-17	705	TD-150-300-17	795
	18	10	TD-150-150-18	495	TD-150-200-18	555	TD-150-250-18	575	TD-150-300-18	635
200	18	10	TD-200-150-18	665	TD-200-200-18	705	TD-200-250-18	745	TD-200-300-18	855
	19	13	TD-200-150-19	545	TD-200-200-19	585	TD-200-250-19	615	TD-200-300-19	695
300	19	12	TD-300-150-19	745	TD-300-200-19	795	TD-300-250-19	875	TD-300-300-19	935
	20	15	TD-300-150-20	645	TD-300-200-20	685	TD-300-250-20	715	TD-300-300-20	725
400	23	17	TD-400-150-23	810	TD-400-200-23	865	TD-400-250-23	920	TD-400-300-23	965
	24	19	TD-400-150-24	675	TD-400-200-24	715	TD-400-250-24	745	TD-400-300-24	755
500	24	18	TD-500-150-24	875	TD-500-200-24	935	TD-500-250-24	965	TD-500-300-24	995
	25	20	TD-500-150-25	705	TD-500-200-25	745	TD-500-250-25	775	TD-500-300-25	785

[1]Guaranteed alpha resolution is through the rear electrode for thickness ≤500 μm and through the front electrode for thicknesses >500 μm, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]TD Series detectors supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 5. TP Series Transmission Planar Detectors

Active Area (mm^2)	Maximum Thickness Variation (Microns)	Depletion Depth (Range)							
		40 μm (35.1-45 μm)		50 μm (45.1-65 μm)		75 μm (65.1-85 μm)		100 μm (85.1-110 μm)	
		Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	±0.5	TP-25-40-15	815	TP-25-50-15	690	TP-25-75-15	655	TP-25-100-15	575
50	±0.5	TP-50-40-20	1090	TP-50-50-15	950	TP-50-75-15	835	TP-50-100-15	745
100	±1.0	TP-100-40-25	1295	TP-100-50-25	1080	TP-100-75-20	975	TP-100-100-20	885
150	±1.0	TP-150-40-35	1420	TP-150-50-30	1180	TP-150-75-30	1065	TP-150-100-25	945
200	±1.0	TP-200-40-40	1595	TP-200-50-35	1390	TP-200-75-35	1145	TP-200-100-25	1015
300	±1.0	TP-300-40-50	1910	TP-300-50-45	1540	TP-300-75-40	1335	TP-300-100-30	1245

[1]Last two (2) digits of model number indicate total system noise width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time), for the thinnest detector (highest capacitance) in each thickness range.

[2]TP Series detectors are supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Continued

Depletion Depth (Range) 400 μm (351-450 μm)		Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range) 500 μm (451-550 μm)		700 μm (650-750 μm)		1000 μm (950-1050 μm)	
Model No.	Price	α	β	Model No.	Price	Model No.	Price	Model No.	Price
TD-25-400-15	615	15	7	TD-25-500-15	815	TD-25-700-15	1385	TD-25-1000-15	1685
TD-25-400-16	465	16	8	TD-25-500-16	615	TD-25-700-16	945	TD-25-1000-16	1225
TD-50-400-15	665	15	7	TD-50-500-15	1205	TD-50-700-15	1495	TD-50-1000-15	1785
TD-50-400-16	555	16	8	TD-50-500-16	875	TD-50-700-16	1075	TD-50-1000-16	1345
TD-100-400-16	835	16	9	TD-100-500-16	1235	TD-100-700-16	1625	TD-100-1000-16	1815
TD-100-400-17	675	17	10	TD-100-500-17	905	TD-100-700-17	1205	TD-100-1000-17	1475
TD-150-400-17	905	17	9	TD-150-500-17	1285	TD-150-700-17	1715	TD-150-1000-17	1885
TD-150-400-18	725	18	10	TD-150-500-18	945	TD-150-700-18	1275	TD-150-1000-18	1605
TD-200-400-18	995	18	10	TD-200-500-18	1375	TD-200-700-18	1815	TD-200-1000-18	1945
TD-200-400-19	785	19	13	TD-200-500-19	1035	TD-200-700-19	1375	TD-200-1000-19	1735
TD-300-400-19	1125	19	13	TD-300-500-19	1485	TD-300-700-19	1985	TD-300-1000-19	2075
TD-300-400-20	895	20	14	TD-300-500-20	1145	TD-300-700-20	1535	TD-300-1000-20	1925
TD-400-400-23	1175	20	15	TD-400-500-20	1575	TD-400-700-20	2025	Special Order	
TD-400-400-24	930	22	17	TD-400-500-22	1185	TD-400-700-22	1580		
TD-500-400-24	1225	21	16	TD-500-500-21	1665	TD-500-700-21	2065	Special Order	
TD-500-400-25	965	23	18	TD-500-500-23	1225	TD-500-700-23	1625		

Table 6. HI Series Heavy Ion Detectors

Active Area (mm^2)	Guaranteed Max Noise (keV)	Minimum Sensitive Depth ≥60 μm: Field Strength ≥15 kV/cm		Field Strength ≥10 kV/cm	
		Model No.	Price	Model No.	Price
100	18	HI-100-60-18	395		
	28			HI-100-60-28	265
300	23	HI-300-60-23	525		
	33			HI-300-60-33	395
400	28	HI-400-60-28	765		
	38			HI-400-60-38	635
500	30	HI-500-60-30	1015		
	44			HI-500-60-44	895
600	33	HI-600-60-33	1375		
	50			HI-600-60-50	1235
1000	38	HI-1000-60-38	2095		
	55			HI-1000-60-55	1955

Note: All HI Series Detectors are ultra-close mount (≤0.040")

[1]Guaranteed max noise is approximated by pulser width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time).

[2]Active surface <1 mm from front of housing.

[3]Performance guaranteed for six (6) months (does not include leakage current increases due to radiation damage).

[4]HI Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 7.
CAM 500 Series Continuous Air Monitoring Alpha Detectors

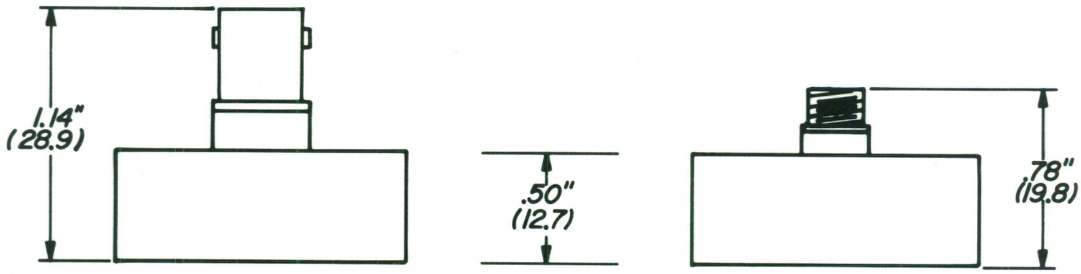
Area (mm^2)	Connector	Model No.	Price
500	BNC	CAM 500 B	295
500	Microdot	CAM 500 M	295

Table 8.
HE 500 Series Harmful Environment Alpha Detectors

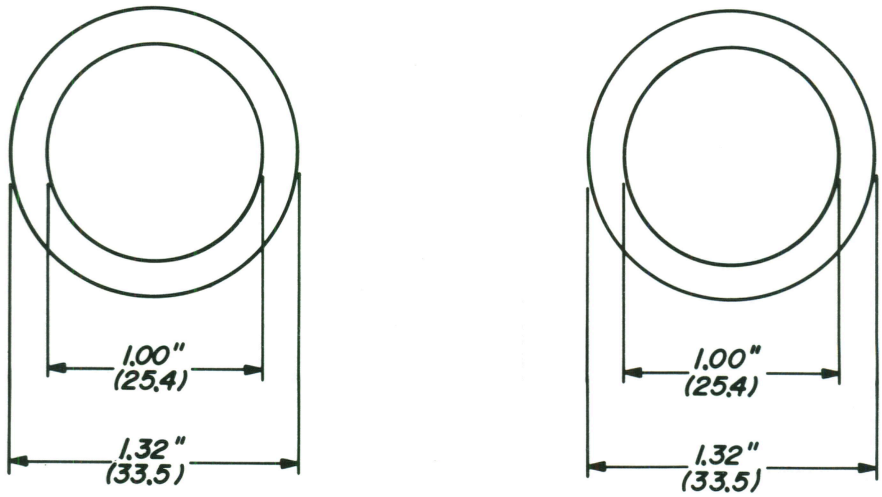
Area (mm^2)	Connector	Model No.	Price
500	BNC	HE 500 B	495
500	Microdot	HE 500 M	495

CAM 500 and HE 500 Mount Dimensions

CAM 500B **CAM 500M**



BNC *93Ω Microdot*



Price Schedule for Quantity Discounts			
CAM 500 Series		HE 500 Series	
Quantity	Price	Quantity	Price
1 to 9	295	1 to 9	495
10 to 24	265	10 to 24	465
25 to 99	245	25 to 99	435
100 to 199	225	100 to 199	410
200 to 399	210	200 to 399	390
400 and up	200	400 and up	370

Alpha Spectrometers

Component Systems

With the use of TENNELEC's TV-1 Vacuum Chamber and selected electronic NIM modules a high quality Single Channel Alpha System can be configured. This can be a simple counting system with the use of a Single Channel Analyzer (SCA) and Counter and Timer or a Spectroscopy System with the use of a Multichannel Analyzer (MCA). By using a deeper detector, these systems can also be used for Beta detection.

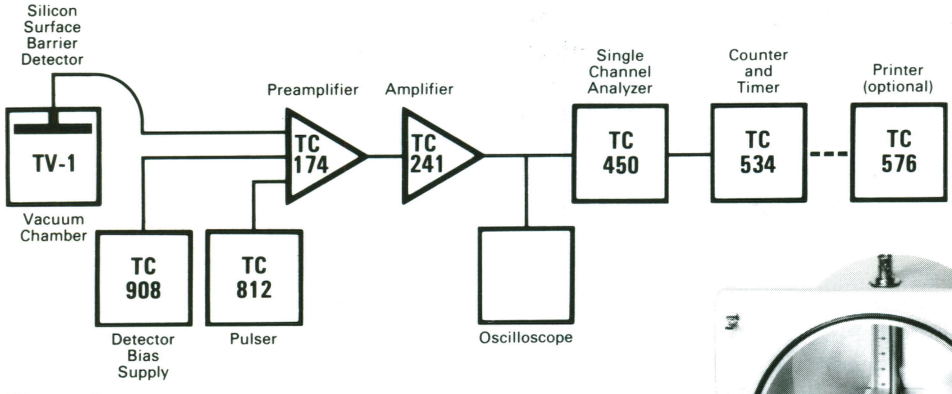
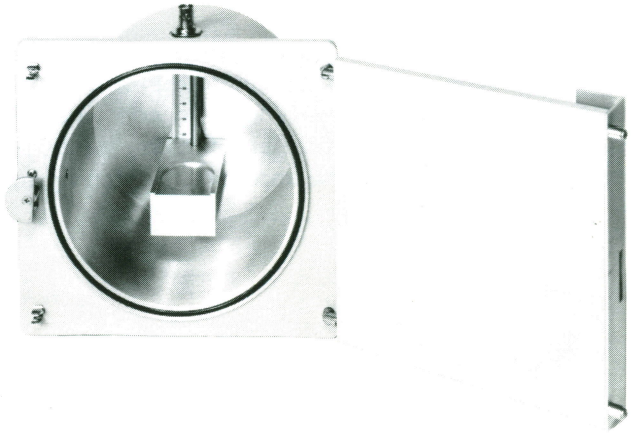


Figure 1
Single Channel Alpha Counting System



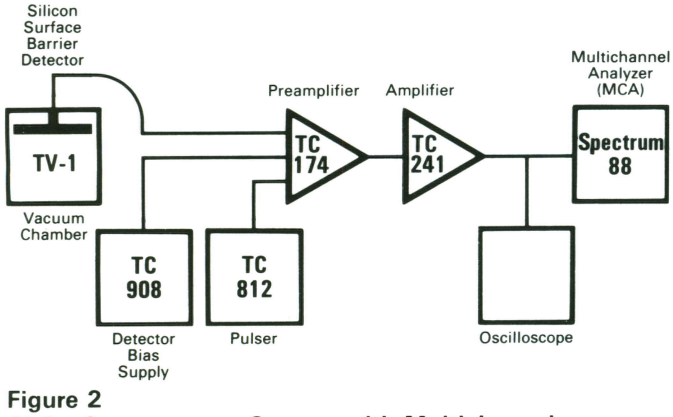
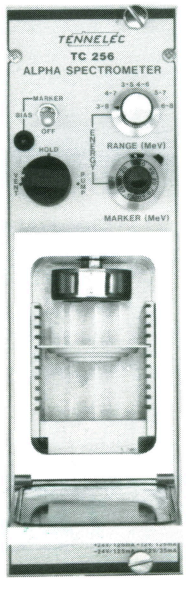


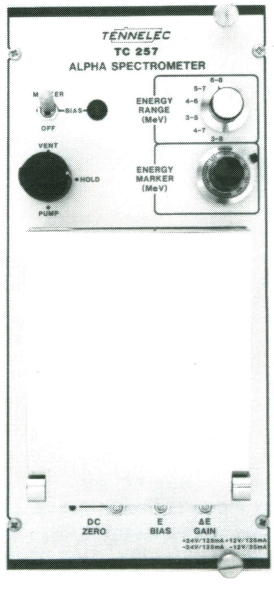
Figure 2
Alpha Spectroscopy System with Multichannel Analyzer (MCA)

Compactly Packaged Systems

TENNELEC produces two complete alpha spectrometers packaged in a double-width NIM module, the TC 256, and a triple-width NIM module, the TC 257. These units contain a vacuum chamber, charge sensitive preamplifier, linear amplifier, discriminator, biased amplifier, variable high voltage supply and adjustable test pulser and are specifically designed for operation with silicon surface barrier detectors.

If you have samples of 1.75 inch diameter or less, the TC 256 is recommended. Should your samples be larger than 1.75 inches, the TC 257 is recommended. The TC 257 will accommodate samples up to 2.25 inches in diameter and accepts the stainless steel sample carriers that are used in TENNELEC's Low Background Alpha/Beta/Gamma counting systems.





Ordering Information

Weight (Shipping) 1.0 lbs (0.45 kg)
(Net) 0.2 lbs (0.09 kg)

Instruction manual and performance test record (one each) provided for each detector shipped.

Accessory included One pair of latex gloves is provided to handle your detector.

Shipping Methods We normally ship via U.P.S. Other shipping methods will be followed at your request.

Packaging TENNELEC silicon charged particle detectors are covered with a front-electrode protective cap; placed in a polyethylene hinged-lid container and sealed inside of a moisture-proof, 5 mil plastic bag before being placed in the appropriate shipping container for the shipping method selected. This packaging technique is suitable for all types of surface and air transportation.

Warranty TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

Payment Terms 1% 10, net 30 days.

TENNELEC, INC.
601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone (615) 483-8405 TWX 810-572-1018

TENNELEC

TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

DO 485 3.0K

TENNELEC

TC 145
Scintillation Preamplifier

DESCRIPTION

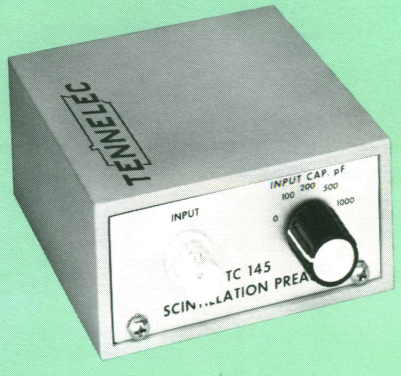
TENNELEC's TC 145 Scintillation Preamplifier is a **noninverting, unity gain preamplifier** designed for use with photomultiplier tube scintillation detectors. The input to the preamplifier can be derived from either the dynode or anode of the PMT.

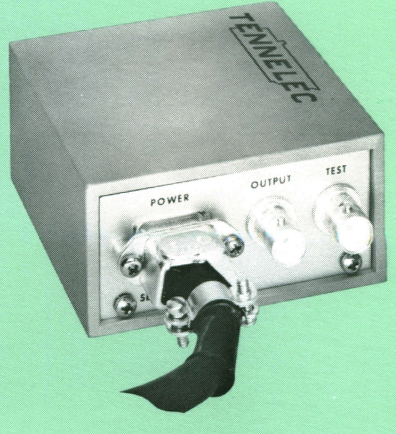
Switch-selectable input capacities provide effective signal attenuation for a wide range of energy measurements.

A **diode protection network** prevents destruction of the input transistor if a sudden positive or negative high voltage transient is applied to the input.

When used with TENNELEC amplifiers, the TC 145 provides an input to the amplifier and can accept a test pulse from the amplifier without the need for external cabling. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need and expense of conventional cabling.

- **Non-inverting, unity gain**
- **Switch-selectable input capacities**
- **Diode protection network**
- **Exclusive "one cable preamplifier connection"**





SPECIFICATIONS

PERFORMANCE

RISE TIME <40 nsec

DECAY TIME ≈50 μsec

INTERGRAL NONLINEARITY≤0.15%

TEMPERATURE COEFFICIENT ±0.01%/°C

NOISE <0.1 mV rms at output

CONTROLS

INPUT CAPACITY Switch selectable input capacities: 0, 100, 200, 500, 1000 pF.

INPUTS

SIGNAL BNC connector accepts positive or negative signal: isolated for 1000 V.

TEST BNC connector accepts signal from pulse generator with fast risetimes to check operation of the preamplifier; input impedance 50 Ω.

OUTPUT

BNC connector; Output impedance 50 Ω. Preamp provides ±10 V into an open circuit; ±5.0 V into a 50 Ω load.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 30 mA
−24 V, 0 mA; −12 V, 30 mA

WEIGHT (SHIPPING) 3 lbs. (1.4 kg)
(NET) 1.1 lb. (0.5 kg)

DIMENSIONS 3 x 3 x 1.5 in. (7.6 x 7.6 x 3.8 cm)

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 145 10.0K 885

TENNELEC

TC 148A
GM Tube Preamplifier

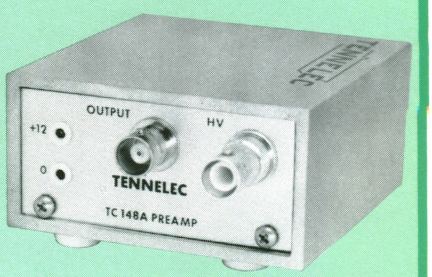
DESCRIPTION

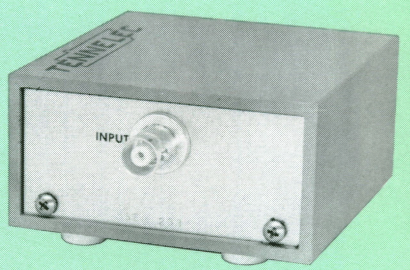
The TC 148A is a **compact charge-sensitive** preamplifier intended for use with GM counters.

The unit is **powered from the detector bias supply** and will operate in the range from +300V to +1200V. Current drain varies from 0.25 mA at 300V to 1 mA at 1200V. The GM tube connects directly to the input connector of the TC 148A, requiring no separate high-voltage connection. Signal output is via a BNC connector.

The TC 148A can be used with a scintillation counter (PM tube), but this usage is not normally recommended. A separate HV connection will be required to supply the dynode resistors of the PMT. If used with a PM tube, the anode should be connected to the preamplifier input terminal. The anode load resistor may have any value between 100K ohms and open circuit, and the same detector bias supply should be used to operate both the preamplifier and the photomultiplier tube.

- **Charge Sensitive**
- **Compact Size**
- **Powered from Detector Bias Supply**





SPECIFICATIONS

PERFORMANCE

RISE TIME <0.1 μsec

DECAY TIME ≃50 μsec

CHARGE SENSITIVITY 10mV per pico Coulomb

NOISE $<5 \times 10^{-15}$ Coulombs rms

DYNAMIC RANGE (Linear Output) +1V into 1KΩ or higher load resistance

INPUTS

HV SHV connector for detector voltages from +300V to +1200V, with 1.2 Meg ohm equivalent supply loading.

GM TUBE MHV connector to GM tube.

POWER Operating power derived from the H.V. power supply, nominally 1mA, or via input jack connectors if detector bias supply has less than 1mA current capability at 1200 volts.

OUTPUTS

BNC connector provides positive linear signal output. Output is inverse of negative polarity input and suitable for counting by any TENNELEC counter. Permissible output cable length is 25 feet. Cable must be terminated into 1KΩ or greater.

ORDERING INFORMATION

WEIGHT (SHIPPING) 3 lbs. (1.4 kg)
(NET) 1 lb. (0.5 kg)

DIMENSIONS 4.0" L x 3" W x 1.5" H (10.2 cm x 7.6 cm x 3.8 cm)

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 148A 10.0K 985

TENNELEC

TC 154
Photomultiplier Tube Base

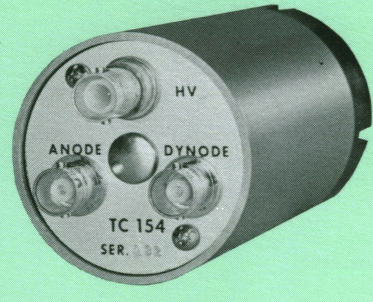
DESCRIPTION

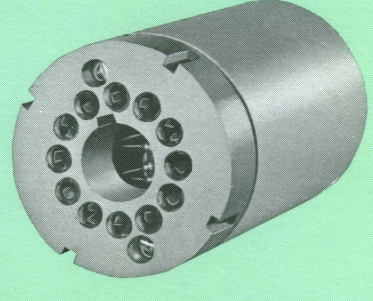
The TENNELEC TC 154 Photomultiplier Tube Base **provides voltage distribution to most ten-stage, 12-pin photomultiplier tubes (PMT's).**

Two advantages of the TC 154 are its **compact** size and it **mounts directly to the PMT**, thus providing an integral assembly.

Capacitively coupled **linear output signals are available from both the anode and tenth dynode**. This provides both negative and positive output signals for timing or linear pulse height analysis systems.

- **Provides voltage distribution to most ten-stage, 12-pin photomultiplier tubes**
- **Mounts directly to PMT**
- **Linear output signal available from anode and ninth dynode**





SPECIFICATIONS

PERFORMANCE

BLEEDER RESISTANCE 2.9 MΩ total, tapped to provide proportional bias steps to successive tube elements.

INPUT

HV An SHV connector accepts positive bias voltages to 1.5 kV.

OUTPUT

ANODE BNC connector provides a negative linear output Zo = 1.0 MΩ; capacitively coupled.

DYNODE BNC connector provides a positive linear output from the tenth dynode. Zo = 1.0 MΩ, capacitively coupled.

ORDERING INFORMATION

POWER REQUIREMENTS None

WEIGHT (SHIPPING) 3 lbs. (1.3 kg)
(NET) 1 lb. (0.5 kg)

DIMENSIONS 2.0 inches diameter by 4.2 inches long (5.1 cm x 10.7 cm), excluding HV and signal connectors.

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TC 154 10.0K 885

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TENNELEC

TC 154A
Photomultiplier Tube Base With Preamplifier

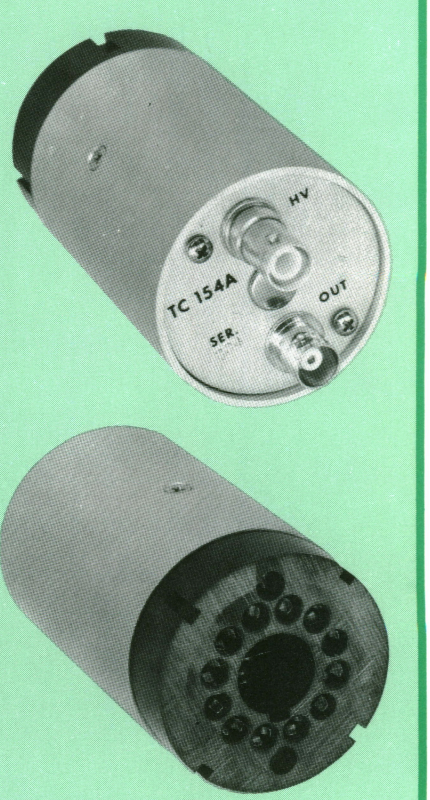
DESCRIPTION

The TENNELEC TC 154A Photomultiplier Tube Base and Preamplifier incorporates a photomultiplier tube base with a voltage divider network and a **built-in charge sensitive preamplifier** into a **compact** assembly. The Photomultiplier Tube Base provides voltage distribution to essentially all ten-stage photomultiplier tubes that fit a standard 12-pin tube socket.

The preamplifier which is an integral part of the base is a charge-sensitive type. A diode protection network has been incorporated into the preamplifier to prevent damage to the internal transistors due to sudden application or removal of bias voltage.

No additional power supply is required as the preamplifier obtains all necessary power directly from the dynode resistor chain.

- **Built-in charge sensitive preamplifier**
- **No external power required for preamplifier**
- **Focus control for optimum performance**
- **Compact**



SPECIFICATIONS

PERFORMANCE

INTEGRAL NONLINEARITY 0.1%, 0 to 1.0 V

TEMPERATURE STABILITY $<\pm 0.01\%/°C$, 0° to 50°C

OUTPUT RISE TIME < 50 nsec

OUTPUT FALL TIME 100 μsec

OUTPUT NOISE $< 1 \times 10^{-15}$ coulombs rms

CONVERSION GAIN 20 mV/pico coulomb

SATURATION LEVEL 4.0 V

BLEEDER RESISTANCE 1.0 M ohms total, tapped to provide proportional bias steps to successive tube elements.

INPUTS

HV Type SHV connector accepts positive bias voltage to 2.5 kV.

OUTPUTS

OUT Type BNC connector furnishes preamplifier positive output pulse, 0 - 4.0 V maximum. Z_o = 50 ohms.

ORDERING INFORMATION

POWER REQUIRED Obtained from dynode resistor chain.

WEIGHT (SHIPPING) 3 lbs. (1.3 kg)
(NET) 1.5 lbs. (0.68 kg)

DIMENSIONS 2.0 inches diameter by 4.2 inches long (5.1 cm x 10.7 cm).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TENNELEC INC.

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

PHONE 615-483-8405 TWX 810-572-1018

TC 154A 10.0K 882

TENNELEC

TC 155
Photomultiplier Tube Base

DESCRIPTION

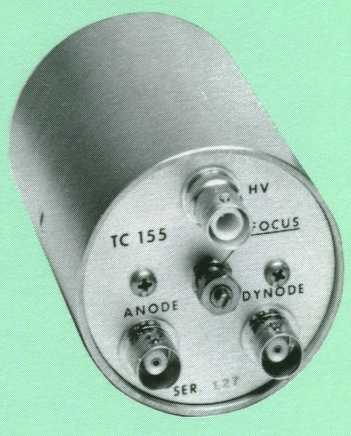
The TENNELEC TC 155 Photomultiplier Tube Base **provides voltage distribution to most ten-stage, 14-pin photomultiplier tubes (PMTs).**

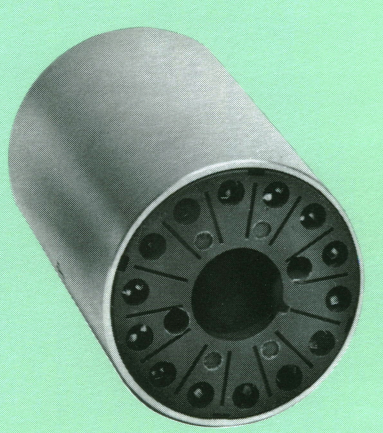
Two advantages of the TC 155 are its **compact** size and it **mounts directly to the PMT**, thus providing an integral assembly.

Capacitively coupled **linear output signals are available from both the anode and ninth dynode**. This provides both negative and positive output signals for timing or linear pulse height analysis systems.

A **focus control** on the TC 155 allows optimum adjustments for the best performance of a particular PMT.

- **Provides voltage distribution to most ten-stage, 14-pin photomultiplier tubes**
- **Compact**
- **Mounts directly to PMT**
- **Linear output signal available from anode and ninth dynode**
- **Focus control**





SPECIFICATIONS

PERFORMANCE

BLEEDER RESISTANCE 2.9 MΩ total, tapped to provide proportional bias steps to successive tube elements.

CONTROL

FOCUS The voltage to the focus electrode in the tube is available as an external trim adjustment using a screwdriver potentiometer.

INPUT

HV SHV connector accepts positive bias voltage to 2.5 kV maximum.

OUTPUT

ANODE BNC connector provides negative linear output through Z_o = 1.0 MΩ, capacitively coupled.

DYNODE BNC connector provides capacitively coupled positive linear output signal tapped from the ninth dynode. 1.0 MΩ dynode load resistor.

ORDERING INFORMATION

POWER REQUIREMENTS
+1 kV @ 0.32 mA typical,
+2.5 kV @ 0.9 mA maximum.

WEIGHT (SHIPPING) 2.12 lbs. (0.96 kg)
(NET) 0.81 lbs. (0.37 kg)

DIMENSIONS 2.0"(5.1 cm) diameter by 4.2" (10.7 cm) long.

INSTRUCTION MANUAL One provided with each instrument.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

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TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 155 10.0K 885

TENNELEC

TC 155A
Photomultiplier Tube Base With Preamplifier

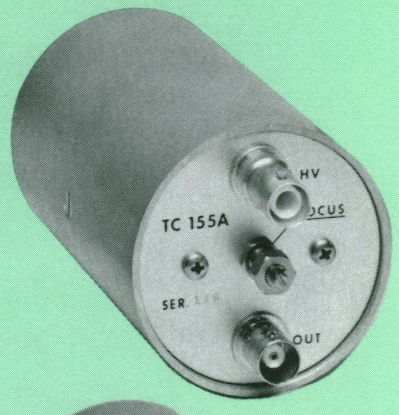
DESCRIPTION

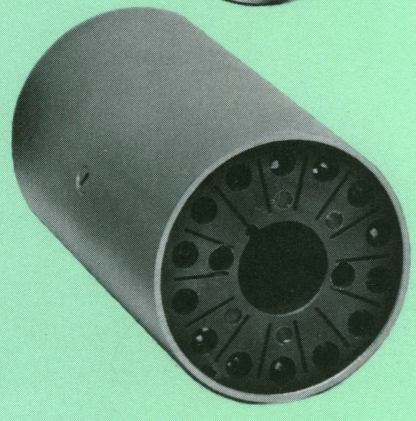
The TC 155A Photomultiplier Tube Base with Preamplifier **provides voltage distribution to most ten-stage, 14-pin photomultiplier tubes (PMTs)**. In addition, a **built-in charge sensitive preamplifier** provides an output to an amplifier for linear pulse height analysis.

No external power is required for the preamplifier, eliminating the need for a separate preamplifier power cord. All necessary power is obtained directly from the dynode resistor chain. A **diode protection network** buffers the internal transistors from damage due to high voltage transients such as sudden application or removal of bias voltage.

A **focus control** on the TC 155A allows optimum adjustments for the best performance of a particular PMT. It's **compact** size allows the TC 155A to couple directly to a PMT, thus forming an integral assembly.

- **Provides voltage distribution to most ten-stage, 14-pin photomultiplier tubes (PMTs)**
- **Built-in charge sensitive preamplifier**
- **No external power required for preamplifier**
- **Diode protection network**
- **Focus control**
- **Compact**





SPECIFICATIONS

PERFORMANCE

INTEGRAL NONLINEARITY 0.1%, 0 to 1.0 V

TEMPERATURE INSTABILITY $<\pm 0.01\%/°C$, 0° to 50°C

OUTPUT RISE TIME <50 nsec

OUTPUT FALL TIME 100 μsec

OUTPUT NOISE $<1 \times 10^{-15}$ coulombs rms

CONVERSION GAIN 20 mV/pico coulomb

SATURATION LEVEL 4.0 V

BLEEDER RESISTANCE 1.0 MΩ total, tapped to provide proportional bias steps to successive tube elements.

CONTROLS

FOCUS Panel-mounted single-turn potentiometer for focus electrode adjustment.

INPUTS

HV SHV connector accepts positive bias voltage to 2.5 kV.

OUTPUTS

OUT BNC connector furnished preamplifier positive output pulse, 0-4.0 V maximum, $Z_o = 50\Omega$.

ORDERING INFORMATION

POWER REQUIREMENTS
+1 kV @ 1 mA typical,
+2.5 kV @ 2.5 mA maximum.

WEIGHT (SHIPPING) 3 lbs. (1.3 kg)
(NET) 1.5 lbs. (0.68 kg)

DIMENSIONS 2.0" (5.1 cm) diameter by 4.2" (10.7 cm) long.

INSTRUCTION MANUAL One provided with each instrument.

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TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 155A 10.0K 885

TENNELEC

TC 170/TC 171
Preamplifiers

DESCRIPTION

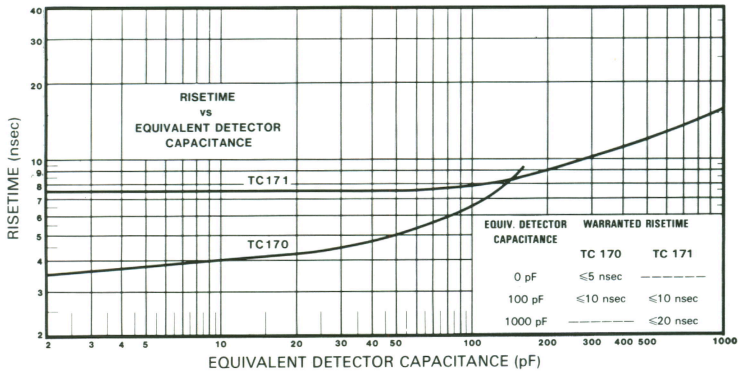
The TENNELEC TC 170 and TC 171 Preamplifiers are **fast-risetime low-noise charge-sensitive** preamplifiers designed to provide optimum performance from **any charged particle detector.**

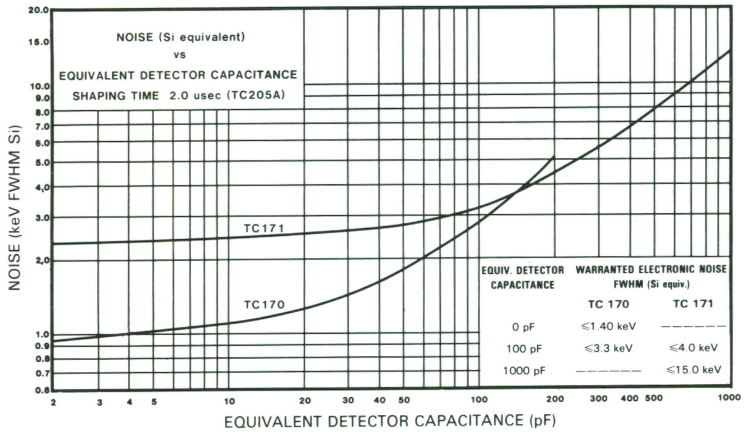
The TC 170 is ac-coupled and intended for use with low-leakage, room-temperature, **low-capacitance silicon detectors,** or low-energy, low-voltage proportional counters.

The TC 171 is ac-coupled and intended for use with higher leakage, room-temperature, **high-capacitance silicon detectors**, or BF_3 proportional counters, etc.

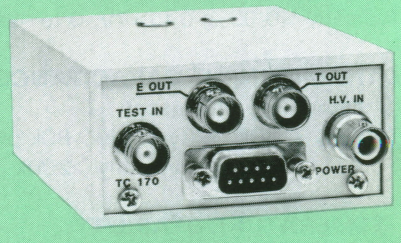
Front-panel BNC connectors are provided for test pulse input and signal outputs. Signal lines are also provided in the preamplifier power cable for a differential-driven energy (E) output and a test input. These features significantly reduce cable clutter, and the differential energy (E) output (when used with a shaping amplifier having a differential input) eliminates ground noise pickup associated with long cable lengths.

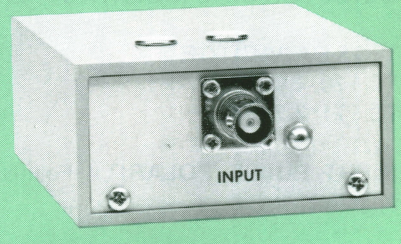
The TC 170/TC 171 have separate **energy and timing outputs.** The timing output is differentiated with a 100 nsec time constant and inverted by a wideband transformer. The shape of the timing output signal permits direct coupling to timing filter amplifiers or fast discriminators.

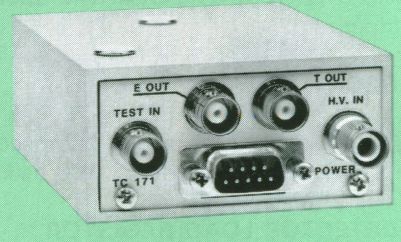




- **Low-noise charge-sensitive design**
- **Optimized for charged particle detectors**
  TC 170 — Low Capacitance
  TC 171 — High Capacitance
- **Independent energy and timing outputs**







TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 170/TC 171
Preamplifiers

SPECIFICATIONS

PERFORMANCE

SENSITIVITY

	TC 170	TC 171
mV/MeV Si	44	20
μV/ion pair	0.16	0.073
V/pc	1.0	0.454

INTEGRAL NONLINEARITY
(Shaping time of 2 μsec)
≤0.05% for 0 to ±10V, unterminated output (typically <0.03%)
≤0.02% for 0 to ±7V, unterminated output (typically <0.005%)

DIFFERENTIAL NONLINEARITY
(Shaping time of 2 μsec)
Typically ≤0.03%; 0 to +7V, 0 to -9V

DYNAMIC INPUT CAPACITANCE
(Shaping time of 2 μsec)
TC 170 ≥40k pF (typically >80k pF)
TC 171 ≥60k pF (typically >200k pF)

TEMPERATURE STABILITY
TC 170 ≤ ±50 ppm/°C; 0° to 50°C
TC 171 ≤ ±75 ppm/°C; 0° to 50°C

DETECTOR BIAS ISOLATION ±2000V

TEST CAPACITOR
TC 170 1.0 pF
TC 171 2.2 pF

INPUT PULSE POLARITY Positive or negative

ENERGY OUTPUT POLARITY Inverse of input

TIMING OUTPUT POLARITY Same as input

DECAY TIME

	TC 170	TC 171
E out	1.0 msec	2.2 msec
T out	100 nsec	100 nsec

DETECTOR LOAD RESISTOR

TC 170	TC 171
210 Meg ohms	110 Meg ohms
(100 + 100 + 10)	(100 + 10)

MAXIMUM ENERGY
TC 170 >200 MeV
TC 171 >400 MeV

COUNT RATE CAPABILITY

	1 MeV (Si)	10 MeV (Si)
TC 170	1.6×10^7 cps	1.5×10^5 cps
TC 171	3.6×10^7 cps	3.5×10^5 cps

INPUTS

INPUT BNC connector accepts positive or negative charge input from any type detector.

TEST BNC connector accepts signals from pulse generator to check operation of preamplifier and/or calibrate the system. Z_{in} = 50 ohms.

H.V. SHV connector accepts up to ±2000 volts and applies it to the detector through the signal connector.

POWER Operating power is applied via a 10 foot preamp power cable from any TENNELEC main amplifier or preamp power supply. Additional signal lines are provided for test pulse input and a differential-driven energy (E) output (one 50 ohm series terminated cable driven by the energy signal and one undriven cable terminated in its characteristic impedance of 50 ohms). Preamp power connector pin assignments are compatible with the connectors on other commercially available amplifiers.

OUTPUTS

E OUT BNC connector provides positive or negative linear pulse for energy measurement. Output pulse polarity is opposite of input polarity. Linear output also provided via preamplifier power cable. Z_o = 50 ohms.

T OUT BNC connector provides fast rise-time differentiated output. This signal may be directly coupled to timing instruments such as timing filter amplifiers and fast discriminators. Z_o = 50 ohms.

ORDERING INFORMATION

POWER REQUIREMENTS

TC 170
+24 V, 35 mA; +12 V, 12 mA
-24 V, 15 mA; -12 V, 12 mA

TC 171
+24 V, 65 mA; +12 V, 12 mA
-24 V, 15 mA; -12 V, 12 mA

WEIGHT (SHIPPING) 3.0 lbs. (1.4 kg)
(NET) 1.1 lbs. (0.5 kg)

DIMENSIONS (L x W x H) 4 x 3 x 1.5 inches; 10.2 x 7.6 x 3.8 cm.

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One (1) TENNELEC NC-PAC-10 ten foot preamplifier signal and power cable provided with each preamplifier ordered; Amphenol 17-20090 to Amphenol 17-10090 connector (shown below).

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 170-171 10.0K 584

TENNELEC

TC 174
Preamplifier

DESCRIPTION

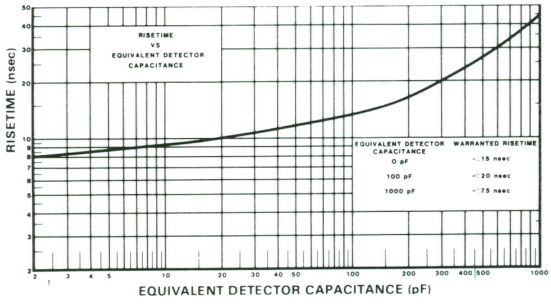
The TENNELEC TC 174 **charge-sensitive preamplifier is an economical general-purpose preamplifier for use with room temperature charged-particle detectors.**

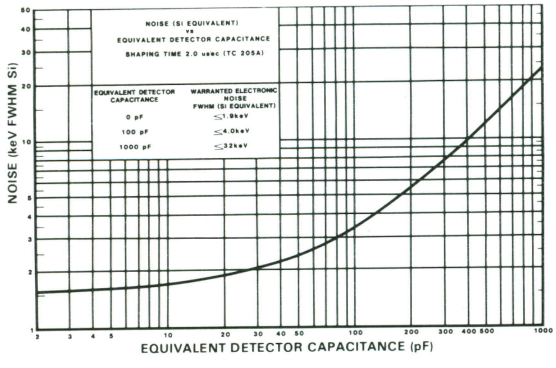
The TC 174 is ac-coupled and intended for use with room temperature silicon detectors, low-energy, low-voltage proportional counters, ionization chambers, low-gain photomultiplier tubes, etc. The TC 174 preamplifier is designed to operate with detector capacitances up to 2000 pF.

Rear-panel BNC connectors are provided for test pulse input, **energy and timing outputs**. Signal lines are also provided in the preamplifier power cable for a differentially-driven energy output and a test input. These features significantly reduce cable clutter, and the differential energy output (when used with a shaping amplifier having a differential input) reduces ground noise pickup associated with long cable lengths.

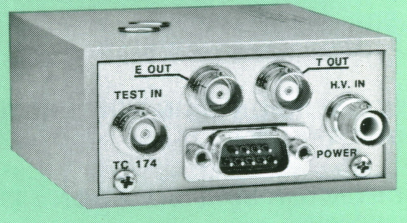
A rear-panel SHV connector accepts the detector bias voltage. This bias voltage is applied to the detector through a front-panel SHV connector where the input signal is also injected and applied to the preamplifier. The TC 174 has a **built-in protection network** to prevent damage to the preamplifier if the input is accidently shorted with high voltage applied.

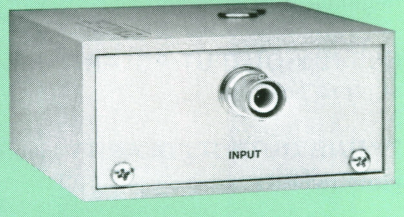
When used with TENNELEC amplifiers, the TC 174 provides an input to the amplifier and can accept a test pulse from the amplifier without the need for external cabling. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need and expense of conventional cabling.





- **Economical charge-sensitive design**
- **Designed for general purpose applications**
- **Energy and Timing Outputs**
- **Built-in HV Protection**
- **Exclusive "one cable preamplifier connection"**





TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 174 Preamplifier

SPECIFICATIONS

PERFORMANCE

SENSITIVITY

mV/MeV Si	44
μV/ion pair	0.16
V/pc	1.0

INTEGRAL NONLINEARITY
(Shaping time of 2 μsec)
≤0.05% for 0 to ±10V unterminated output; typically <0.03%.
≤0.02% for 0 to ±7V unterminated output; typically <0.005%.

DIFFERENTIAL NONLINEARITY
(Shaping time of 2 μsec)
Typically ≤0.03%; for 0 to +7V, 0 to −9V.

DYNAMIC INPUT CAPACITANCE
(Shaping time of 2 μsec)
≥10k pF; typically >15k pF

CONVERSION GAIN TEMPERATURE INSTABILITY ≤±75 ppm/°C; 0° to 50°C

DETECTOR BIAS ISOLATION ±3000V
(±5000V available on special request.)

TEST CAPACITOR 1.0 pF

INPUT PULSE POLARITY Positive or negative

ENERGY OUTPUT POLARITY Inverse of input polarity

TIMING OUTPUT POLARITY Inverse of input polarity

DECAY TIME

E OUT	1.0 msec
T OUT	1.0 msec

DETECTOR LOAD RESISTOR
110 megohms
(100 megohm + 10 megohm)

MAXIMUM ENERGY >200 MeV (Si)

COUNT RATE CAPABILITY

1 MeV (Si)	1.6×10^7 cps
10 MeV (Si)	1.6×10^5 cps

INPUTS

INPUT SHV connector accepts positive or negative charge input from the detector.

TEST IN BNC connector accepts signals from pulse generator to check operation of preamplifier and/or calibrate the system. Z_{in} = 50 ohms.

H.V. IN SHV connector accepts up to ±3000 volts (±5000 volts available by special request) and applies it to the detector through the signal input connector.

POWER Operating power is provided via a 10 foot preamp power cable from any TENNELEC main amplifier or preamp power supply. Additional signal lines are provided for test pulse input and a differentially-driven energy output (one 50 ohm series terminated cable driven by the energy signal and one undriven cable terminated in its characteristic impedance of 50 ohms). Preamp power connector pin assignments are compatible with the connectors on other commercially available amplifiers.

OUTPUTS

E OUT BNC connector provides positive or negative linear pulse for energy measurement. Output pulse polarity is opposite of input polarity. Linear output also provided via preamplifier power cable. Z_o = 50 ohms.

T OUT BNC connector provides positive or negative pulse identical to the energy output pulse. Z_o = 50 ohms.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 35 mA; +12 V, 12 mA
−24 V, 15 mA; −12 V, 12 mA

WEIGHT (SHIPPING) 3.0 lbs. (1.4 kg)
(NET) 1.1 lb. (0.5 kg)

DIMENSIONS (L x W x H) 4 x 3 x 1.5 inches; 10.2 x 7.6 x 3.8 cm.

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED One (1) TENNELEC NC-PAC-10, 10 foot preamplifier signal and power cable provided with each preamplifier ordered; Amphenol 17-20090 to Amphenol 17-10090 connector (shown below).

NC-PAC-10

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 174 10.0K 985

TENNELEC

TC 175
Preamplifier

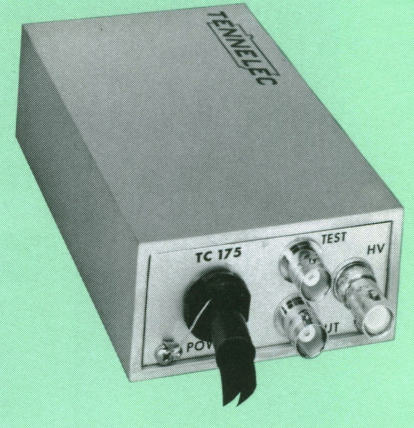
DESCRIPTION

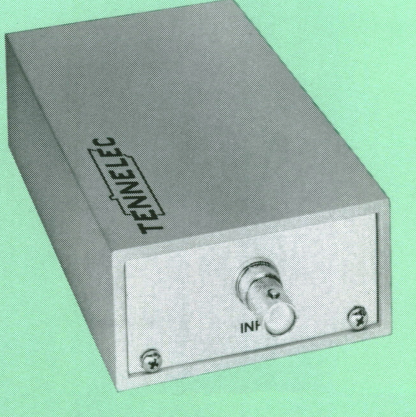
The TENNELEC TC 175 is a charge sensitive preamplifier designed specifically for use with **large area proportional counters** operating at a **maximum bias voltage of 5 kV.**

The **low noise level** is equivalent to 15 eV at an effective gas multiplication factor of 1,000 (P-10 gas) when the external capacitance is 20 pF.

The TC 175 incorporates a protective circuit for the FET to prevent damage from inadvertently applied over voltages.

- **Especially designed for large area proportional counters**
- **Low noise**
- **Detector Bias up to ± 5kV**
- **Excellent integral linearity and temperature stability**





SPECIFICATIONS

PERFORMANCE

SENSITIVITY 200 mV/pC

NOISE 700 ion pairs as measured with a 10 pF detector and a 22 MΩ load resistor.

RISETIME 30 ns at 0 pF; 45 ns at 10 pF; 120 ns at 100 pF.

TEMPERATURE INSTABILITY
<± 0.01%/°C, 0 to 50°C

DETECTOR BIAS ISOLATION
± 5,000 V

INPUTS

INPUT Accepts input signals of positive or negative polarity from a proportional counter and extends operating bias to the proportional counter.

HV Accepts the bias voltage for the proportional counter from a bias supply.

TEST Accepts input voltage pulses from a pulse generator for instrument and system check and calibration; $Z_{in} = 50\ \Omega$.

OUTPUT LINEAR RANGE
-9.5 V to +8.5 V

DYNAMIC INPUT CAPACITANCE
1 nF

INTEGRAL NONLINEARITY <0.05% over the range -9.5 V to +8.5 V.

OUTPUTS

OUT Inverse of input polarity; $Z_o = 50\ \Omega$ through a BNC connector.

CONNECTORS

INPUT AND HV Type SHV

TEST AND OUT Type BNC

POWER Captive 10 ft. (3 m) cable terminated with a 9 pin amphenol type 17-10090 connector.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 32 mA
-24 V, 0 mA; -12 V, 32 mA

WEIGHT
(SHIPPING) 2.4 lbs. (1.09 kg)
(NET) 1.4 lbs. (.64 kg)

DIMENSIONS (LxWxH) 5.2" x 3" x 1.5"; 13.2 cm x 7.62 cm x 3.81 cm

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

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TC 175 10.0K 985

TENNELEC

TC 178/TC 178P
Quad Preamplifier/Quad Pulser

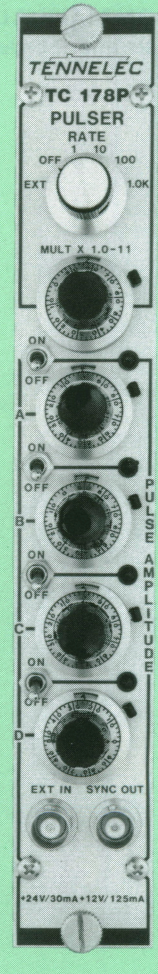
TC 178P Quad Pulser

DESCRIPTION

The TENNELEC TC 178P Quad Pulser is a single-width NIM module that is **dedicated for use with the TC 178 Quad Preamplifier.** The **four independent channels** are designed to provide a dc reference level and a trigger pulse to the pulser section located within the TC 178 Quad Preamplifier. The TC 178P and the TC 178 internal pulser **simulate the detector output signals** from solid-state or other types of radiation detectors. The TC 178P Quad Pulser is useful for both testing and calibration of the nuclear counting system electronics when used in conjunction with the TC 178 Quad Preamplifier.

Each channel of the TC 178P **can be calibrated to read directly in terms of equivalent energy.** The module offers **continuously variable repetition rates** from 1 Hz to 11 kHz to duplicate experimental counting rates. **Individual LED count indicators** give visual feedback of each channel's operation. Separate ON/OFF switches allow operation of any combination of channels.

- **Dedicated Quad Pulser for the TC 178 Quad Preamplifier**
- **Four independent pulser channels**
- **Simulates detector output signals**
- **Each channel can be calibrated to read directly in units of energy**
- **Continuously variable repetition rate**
- **Individual LED count indicators**



SPECIFICATIONS

PERFORMANCE

REPETITION RATE 1 Hz to 11 kHz in 4 ranges; continuously variable for each range.

AMPLITUDE ACCURACY ≤±[25 mV + (Vo DIAL X 2.8 mV)], typically ≤±10 mV of setting

AMPLITUDE TEMPERATURE INSTABILITY
Vo ≥0.4V: <±50 ppm/°C, typically <±20 ppm/°C

Vo <0.4V: ≤±40 ppm/°C, typically <±20 ppm/°C

AMPLITUDE INSTABILITY Independent of 115V line voltage variations. <0.1mV/V for variations of the +24V NIM supply voltage.

RATE INACCURACY ≤±2% of setting, typically <±1%

RATE TEMPERATURE INSTABILITY ≤±200 ppm/°C, typically ≤±50 ppm/°C referenced to +24V

RATE INSTABILITY Independent of 115V line voltage variations. <4.25%/V for variations of the +24V NIM supply voltage.

CONTROLS

RATE Front-panel, six-position rotary switch selects pulser repetition rates of 1,10,100,1.0k Hz, OFF or EXTernal for all four (4) channels.

MULT Front-panel 10-turn potentiometer provides multiplier for repetition rate for all four (4) channels; factors are X1.0 to X11, continuously variable.

PULSE AMPLITUDE Four (4) front-panel 10-turn potentiometer controls output dc level for each channel from 0 to +10V open circuit.

ON-OFF Two-position toggle switch to enable or disable the respective pulser channel, one per channel.

OUTPUTS

SYNC OUT Front- and rear-panel BNC connector provides dc-coupled, 0 to +5V signal open circuit (0 to +2.5V terminated into 50 ohms). Signal width 60 nsec.

PULSER OUT Rear-panel BNC connector, one per channel, dc-coupled, with an amplitude range of 0 to +10V open circuit.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 178P Quad Pulser

INPUTS

EXT IN Front- and rear-panel BNC connector, dc-coupled, accepts positive NIM input (+5V, 500 nsec wide) to provide pulse repetition rates up to 100 kHz for all four (4) channels.

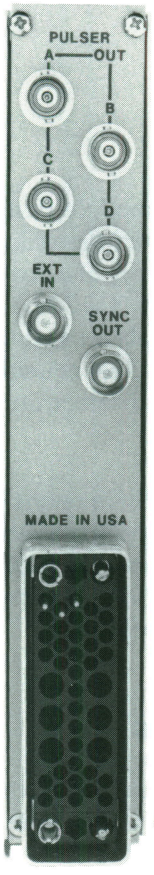
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 30 mA; +12 V, 125 mA
−24 V, 0 mA; −12 V, 0 mA

WEIGHT (SHIPPING) 3.2 lbs. (1.45 kg)
(NET) 2.1 lbs. (.95 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TC 178/TC 178P 10.0K 1184

TENNELEC

TC 178/TC 178P
Quad Preamplifier/Quad Pulser

TC 178 Quad Preamplifier

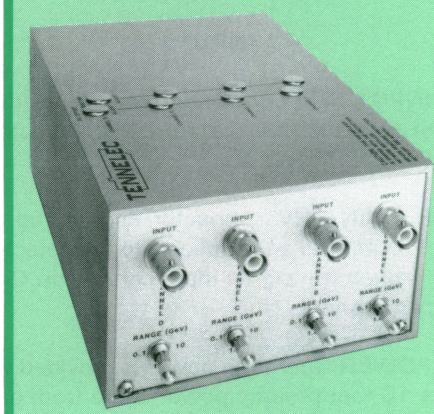
DESCRIPTION

The TENNELEC Model TC 178 Quad Preamplifier and TC 178P Quad Pulser are unique instruments ideally suited for large silicon surface barrier detector arrays. They are equally suitable in applications requiring a large number of charge sensitive preamplifiers and pulsers as they are a cost-effective alternative to expensive, single-input units.

The TC 178 offers **four independent preamplifier channels in a single housing.** Each channel features separate positive/negative input polarity selection, pulser polarity, and energy range. **Selectable energy ranges** are 0-0.1 GeV, 0-1.0 GeV, and 0-10.0 GeV. **Individual pulser calibration** is provided for each channel, (see TC 178P Quad Pulser) and the pulser amplitude can be set to read directly in energy.

LED count indicators provide visual feedback that all channels are processing pulses. A **main power LED indicator** illuminates when input voltage levels are within acceptable limits and goes off if any of the input voltages fall outside of these limits.

- **Four independent preamplifier channels**
- **Selectable energy ranges**
- **Individual pulser calibration**
- **LED count indicators for each channel**
- **Main power LED indicator**



SPECIFICATIONS

PERFORMANCE*

SENSITIVITY (Si)

0 - 0.1 GeV	20 mV/MeV
0 - 1.0 GeV	2.0 mV/MeV
0 - 10 GeV	0.2 mV/MeV

INTEGRAL NONLINEARITY
$\leqslant$0.05% for 0 to ±8V; typically <0.03%, unterminated output.

$\leqslant$0.02% for 0 to ±2V; typically <0.005%, unterminated output.

DIFFERENTIAL NONLINEARITY
Typically $\leqslant$0.03%, 0 to ±8V

DYNAMIC INPUT CAPACITANCE

0 - 0.1 GeV	$\geqslant$10k pF; typically >15k pF
0 - 1.0 GeV	$\geqslant$20k pF; typically >25k pF
0 - 10 GeV	$\geqslant$30k pF; typically >35k pF

CONVERSION GAIN TEMPERATURE INSTABILITY, 0 to 50°C
0 - 0.1 GeV Range
$\leqslant$±100 ppm/°C
0 - 1.0 GeV Range
$\leqslant$±75 ppm/°C
0 - 10 GeV Range
$\leqslant$±50 ppm/°C

DETECTOR BIAS ISOLATION
±1000V

INPUT PULSE POLARITY Positive or negative

DETECTOR LOAD RESISTOR
1 megohm

DECAY TIME 50 μsec

RISETIME

RANGE	DETECTOR CAPACITANCE	TYPICALLY
0 - 0.1 GeV	0 - 200 pF	<30 nsec
0 - 1.0 GeV	0 - 200 pF	<20 nsec
0 - 10 GeV	0 - 200 pF	<10 nsec

MAXIMUM ENERGY

0 - 0.1 GeV	>500 MeV (Si)
0 - 1.0 GeV	>5 GeV (Si)
0 - 10 GeV	>50 GeV (Si)

* Where appropriate, all performance specifications given are for a 2 μsec shaping (4 μsec peaking) time.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 178 Quad Preamplifier

COUNT RATE CAPABILITY
0 - 0.1 GeV (Si) Range
$>1 \times 10^5$ cps @ 100 MeV (Si)
0 - 1.0 GeV (Si) Range
$>1 \times 10^5$ cps @ 1.0 GeV (Si)
0 - 10 GeV (Si) Range
$>1 \times 10^5$ cps @ 10 GeV (Si)

NOISE (Values are typical with protection network in)

	0 pF	100 pF	1k pF
0 - 0.1 GeV	12 keV	15 keV	48 keV
0 - 1.0 GeV	15 keV	18 keV	49 keV
0 - 10 GeV	70 keV	72 keV	98 keV

TEST CAPACITOR One (1) for each ENERGY RANGE and channel

INPUTS

INPUT SHV connector accepts positive or negative charge from the detector. One per channel.

H.V. IN SHV connector accepts up to ±1000 volts and applies it to the detector through the signal input connector. One per channel.

POWER Operating power is provided via a 10 foot preamp power cable from any TENNELEC main amplifier or preamp power supply. Preamp power connector pin assignments are compatible with the connectors on other commercially available amplifiers.

TEST IN BNC connector accepts inputs from the TC 178P QUAD PULSER to set test pulse amplitude and rate. One per channel.

CONTROLS

RANGE Three-position locking-toggle switch allows independent selection of preamplifier energy range. 0 to 0.1 GeV, 0 to 1.0 GeV or 0 to 10 GeV.

PULSER POLARITY Two-position toggle switch allows selection of either positive or negative pulser polarity. One per channel.

PULSER CALIBRATION PCB-mounted variable capacitor allows calibration of pulses such that the TC 178P QUAD PULSER AMPLITUDE control reads directly in energy. One control per range. Each channel independent. (Accessible through bottom of case.)

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 60 mA; +12 V, 100 mA
−24 V, 60 mA; −12 V, 60 mA

WEIGHT (SHIPPING) 3.0 lbs. (1.4 kg)
(NET) 1.1 lb. (0.5 kg)

DIMENSIONS (L x W x H) 8.5 x 5 x 3 inches; (21.6 x 12.7 x 7.6 cm)

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY One (1) TENNELEC NC-PAC-10, 10 foot preamplifier power cable provided with each TC 178 QUAD PREAMPLIFIER ordered; Amphenol 17-20090 to Amphenol 17-10090 connector.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

TC 202BLR
Amplifier

DESCRIPTION

The TENNELEC TC 202BLR is a versatile, high performance spectroscopy amplifier in a single-width NIM module. The performance characteristics of the TC 202BLR make it ideally suited for semiconductor detectors, proportional counters, scintillation detectors and pulse ion chambers.

The TC 202BLR cascades two active-element integrators to provide a **nearly pure gaussian unipolar pulse shape. Switch-selectable shaping times of 0.53, 0.8, 1.6 and 2.4 μsec** allow the TC 202BLR to match the signal processing requirements of most detectors.

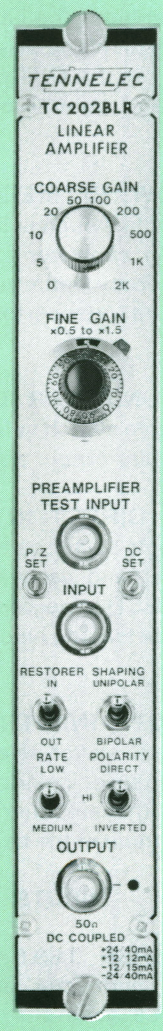
An **active-element baseline restorer** precedes the amplifier driver stage and provides the **superb high count rate performance** typically associated with the most expensive shaping amplifiers. A high, medium and low count rate switch is provided and further enhances the TC 202BLR's performance.

To further increase the TC 202BLR's versatility, it will **accept positive, negative and bipolar shaped inputs** and provides positive or negative polarity unipolar or bipolar shaped outputs.

An **exceptionally wide gain range of X2.5 to X3000** makes the TC 202BLR ideal for all preamplifiers regardless of their sensitivity and for any energy range application. A zero "0" gain position is provided to disable the processing of preamplifier signals by the amplifier.

When used with TENNELEC preamplifiers, the TC 202BLR accepts signals from the preamplifier and supplies a test input pulse to the preamplifier without any additional external cabling between the TC 202BLR and the preamplifier. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need for conventional cabling.

- **Nearly pure gaussian unipolar pulse shape**
- **Four switch-selectable shaping times**
- **Active-element baseline restorer**
- **Superb high count rate performance**
- **Accepts positive, negative and bipolar shaped inputs**
- **Exceptionally wide gain range of X2.5 to X3000**
- **Exclusive "one cable preamplifier connection"**



SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active element, double or single differentiated to produce bipolar and near gaussian shaped unipolar pulses. Shaping times of 0.53, 0.8, 1.6 and 2.4 μsec, internal switch selectable.

GAIN RANGE Continuously variable from X2.5 to X3000.

INTEGRAL NONLINEARITY ⩽ 0.05% over the full rated output range.

NOISE Less than 5 μV referred to the input for 2.4 μsec unipolar shaping time and gain settings greater than 500. Typically less than 10 μV at a gain setting of 60.

TEMPERATURE INSTABILITY
Gain ⩽±0.01%/°C, 0 to 50°C

OPERATING TEMPERATURE
0 to 50°C

OVERLOAD RECOVERY Unipolar output recovers to within 2% of the rated output from X100 overload in approximately 2 non-overloaded pulse widths. Bipolar output recovers to within 2% of the rated output from X1000 overload in approximately 2.5 non-overloaded pulse widths.

CONTROLS

COARSE GAIN Nine-position rotary switch selects gain factors from 5 to 2000 in a 1-2-5 sequence. Zero "0" position disables preamplifier pulse processing.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 202BLR Amplifier

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multiplier of 0.5 and 1.5 respectively. The Fine Gain control extends the total gain range from X2.5 to X3000.

POLE-ZERO (P/Z) SET 22-turn screwdriver adjustable control for cancellation of preamplifier decay times from 35 μsec to infinity.

DC SET 22-turn screw-driver adjustable control for matching the dc output level of the TC 202BLR to the analyzer's input dc level. Adjustable from -3.5 volts to +3.5 volts.

RESTORER IN/OUT Two-position toggle switch enables the baseline restorer in the IN position and disables the baseline restorer in the OUT position, allowing accurate pole-zero cancellation adjustment.

RATE LOW/HI/MEDIUM Three-position toggle switch selects the size of the coupling capacitor to the baseline restorer, thereby optimizing the resolution vs count rate performance of the amplifier.

SHAPING UNIPOLAR/BIPOLAR Two-position toggle switch selects either unipolar or bipolar output pulses.

POLARITY DIRECT/INVERTED Two-position toggle switch selects either positive unipolar and positive lobe leading bipolar (DIRECT) or negative unipolar and negative lobe leading bipolar (INVERTED) output.

BLR + INPUT/- INPUT Rear-panel two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input and for proper operation of the baseline restorer.

INPUTS

PREAMPLIFIER TEST INPUT Front-panel BNC connector accepts signals from a pulse generator and transmits those signals via the preamplifier power cable to any TENNELEC preamplifier. 50 ohm input termination in preamplifier, dc coupled.

INPUT Front-panel BNC connector accepts either positive or negative or bipolar pulses with risetimes less than approximately 2.2X shaping time and decay times of 35 μsec to infinity. Z_{in} = 1500 ohms, ac coupled. This input is in parallel to the signal input provided from TENNELEC preamplifiers via the preamplifier power cable.

OUTPUTS

OUTPUT Front-panel BNC connector provides positive or negative, unipolar or bipolar shaped pulses. Full scale range of 0 to $\pm$ 10 volts ($\pm$ 11.5 volts maximum). Z_{out} = 50 ohms, dc coupled.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 40 mA; +12 V, 12 mA
-24 V, 40 mA; -12 V, 15 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 3.0 lbs. (1.4 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N <2000).

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 202BLR 10.0K 1085

TENNELEC

TC 205A
Linear Amplifier

DESCRIPTION

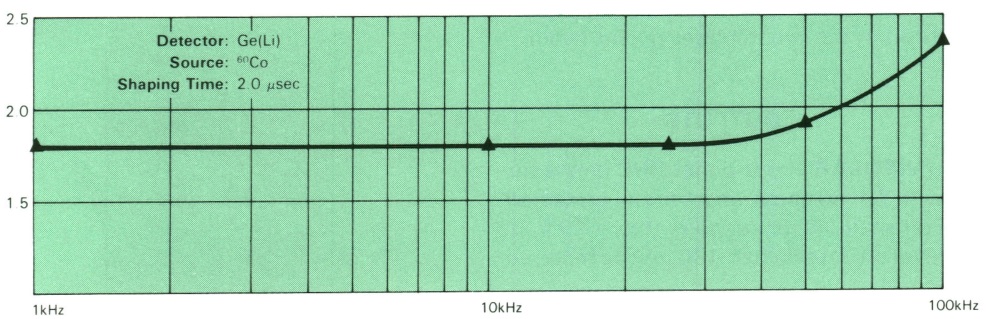
The TENNELEC TC 205A Linear Amplifier is a two-wide NIM module which possesses the latest advances in amplifier design. The availability of **six shaping times** and a **broad gain range (X 2.5 to X 3000)** makes this amplifier ideally suited for use with Germanium and Silicon Detectors, Charged Particle and Proportional Counters, Scintillation Counters and Pulsed Ion Chambers.

The **gated Baseline Restorer** allows the amplifier to have the highest count-rate capability available for a given resolution. In addition, undesirable characteristics such as correlated noise and short-period undershoots have been eliminated. The BLR gate signal is available on the front panel (Busy Output) and can be used for monitoring amplifier dead time.

DC drift in an amplifier output is the primary cause of spectrum broadening. The **excellent dc stability** of the TC 205A eliminates drift and ensures superior performance.

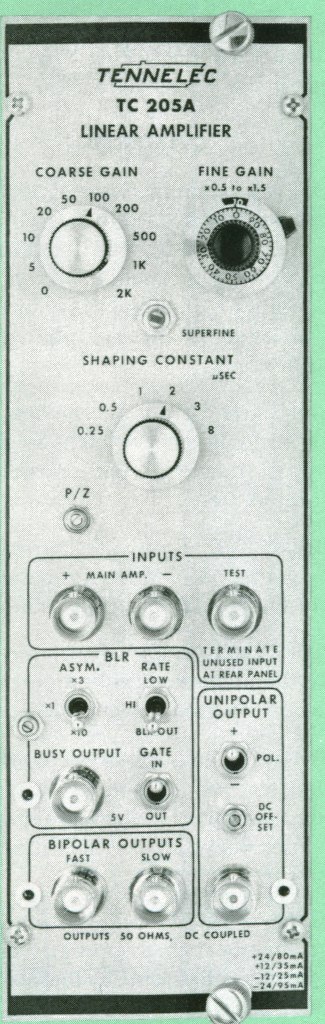
The TC 205A's pulse shaping network allows for optimized sensitivity while have a **noise** content of **less than 3.75 μV** (unipolar). A **differential balanced input** is provided to eliminate noise pickup on long input signal cables.

Excellent timing measurements can be made using the TC 205A because of the **very low crossover walk (<± 1.0 ns).**



Typical Resolution vs Count Rate

- **Gain from X 2.5 to X 3000**
- **Six selectable shaping times**
- **Crossover Walk < 1.0 ns**
- **Less than 0.03% peak shift from 0 to 250 KHz**
- **Noise less than 3.75 μV**
- **Gated Baseline Restorer**
- **0.25 μsec Fast Bipolar output**
- **Differential balanced input**



SPECIFICATIONS

PERFORMANCE

GAIN Continuously adjustable from X 2.5 to X 3000

PULSE SHAPE Unipolar (Gaussian), slow bipolar and fast bipolar

INTEGRAL NONLINEARITY 0.04%, 0 to ± 10 V minimum

NOISE Less than 3.75 μV for unipolar output and less than 5.5 μV for slow bipolar output with 3 μsec shaping and gain >X 40

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 205A Linear Amplifier

TEMPERATURE STABILITY

GAIN <0.01%/°C

DC LEVEL <±50 μV/°C

WALK ≤±1 nsec for fast bipolar output, 0-10 V. Under overload condition (X 100), <±12.5 nsec.

OVERLOAD RECOVERY

Unipolar: Recovers to within 2% of rated output for X 200 overload in 2.5 pulse widths.

Slow Bipolar: Recovers to within 2% of rated output for X 1000 overload in two pulse widths.

SPECTRUM SHIFT Peak position shifts less than 0.03% for a ^{60}CO source at 80% of full scale when internal BLR is used. Countrate range 0-250 KHz at 1 μsec shaping.

CONTROLS

GAIN Ten-position switch selects coarse gain from 0 to X 2000 in steps of 0, 5, 20, 50, 100, 200, 500, 1000, 2000. A zero gain position is provided which disables the amplifier, allowing the user to isolate the preamplifier noise output from the system noise.

FINE GAIN Fine gain factors continuously variable from X 0.5 to X 1.5, set via a ten-turn control with direct-reading calibrated dial.

SUPERFINE One-turn trim control allows the gain to be adjusted ± two channels per 1000 at full scale range.

POLE ZERO (P/Z) Twenty-turn screwdriver adjustable potentiometer to set the pole-zero cancellation from 35 μsec to ∞.

BLR RATE Three-position toggle switch optimizes the Baseline Restorer for medium and high counting rates. A third position, BLR out, disables the Baseline Restorer.

BLR ASYMMETRY Three-position toggle switch permits asymmetry settings of the Baseline Restorer by factors of X 1, X 3, or X 10.

GATE IN/OUT Two-position toggle switch which, when IN, disconnects BLR memory capacitor until pulse passes through the BLR threshold. In the OUT position, this gate is disconnected.

UNIPOLAR +/− Two-position toggle switch selects either positive or negative unipolar output polarity.

DC OFFSET Screwdriver adjustable potentiometer to set the unipolar output dc level; range ± 100 mV.

INPUT POLARITY Two-position slide switch selects either positive (+) or negative (−) input polarity (For TENNELEC Preamplifiers ONLY).

INPUT TERMINATION Three-position slide switch with balanced input for TENNELEC preamplifiers, or +/− termination for other manufacturers' preamplifiers.

INPUTS

SIGNAL INPUT (+ **and** −) Duplicate BNC connectors provided on front and rear panels. Separate connectors for positive and negative inputs. Z_{in} = 1.5 k ohms for positive inputs and Z_{in} = 500 ohms for negative inputs. Both inputs are dc-coupled.

TEST Front- and rear-panel BNC connectors accept test pulse inputs which are routed to TENNELEC preamplifiers through the preamplifier power cable.

OUTPUTS

UNIPOLAR Front-panel BNC connector with Z_o = 50 ohms, short circuit protected. Full scale linear range is 0 to ± 10 V; dc level adjustable to ± 100 mV; dc restored.

BIPOLAR (SLOW) Front-panel BNC connector with Z_o = 50 ohms short circuit protected; full scale linear range ± 10 V.

BIPOLAR (FAST) Front-panel BNC connector with Z_o = 50 ohms short circuit protected; full scale linear range 8 V for 0.1% integral nonlinearity and 0-10 V for 0.2% integral nonlinearity; Crossover walk less than 1.0 nsec; 0.25 μsec DL-RC shaping.

BUSY Front-panel BNC connector provides a + 5 V logic pulse derived from the baseline restorer. The width of the signal is either 20 μsec, or the duration of the gate pulse initiated by the reset signal of a pulsed-optical preamplifier, whichever is longer.

PREAMP POWER Two rear-panel connectors are provided. TENNELEC connector accepts signals from TENNELEC preamplifier and provides power to TENNELEC preamplifiers with S/N's <2000.

NOTE: When using TENNELEC preamplifiers with S/N's >2000 or preamplifiers manufactured by other suppliers, the preamp connector labeled "Other" should be used.

ORDERING INFORMATION

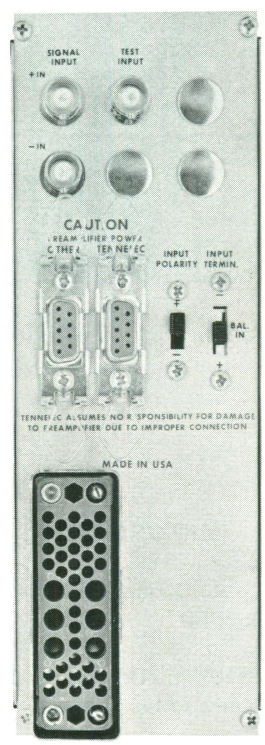
POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 35 mA
−24 V, 110 mA; −12 V, 25 mA

WEIGHT (SHIPPING) 6.6 lbs. (3.0 kg)
(NET) 4.4 lb. (2.0 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 205A 10.0K 882

TENNELEC

TC 215
Delay Amplifier

DESCRIPTION

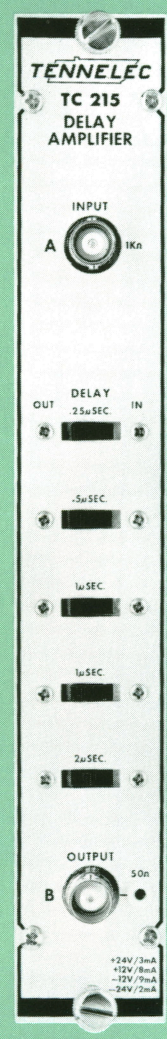
The TENNELEC TC 215 Delay Amplifier is designed for providing variable delays for both logic and linear signals.

The output of the TC 215 can be delayed from 0.25 μsec to **4.75 μsec** with respect to the input by switch selectable time increments of 0.25 μsec. Since the module accepts either positive or negative signals and is completely **dc-coupled,** it can be used with analog or digital signals of any duration.

The **input impedance** is not affected by the selected delay so that no signal loading change occurs.

The TC 215 is capable of very **high counting rates** without distortion.

- **DC-coupled**
- **Input impedance independent of delay**
- **Delay from 0 to 4.75 μsec**
- **High counting rate capability**



SPECIFICATIONS

PERFORMANCE

GAIN Unity ±2%

NONLINEARITY <0.05% of rated output

TEMPERATURE STABILITY <0.01%/°C, 0 to 50°C

FEEDTHROUGH AND REFLECTIONS <1% (for a Gaussian shape pulse, 1 μsec time constant)

RISETIME 100 nsec or 10% of delay time, which ever is greater.

CONTROLS

DELAY Additive delays of 0.25, 0.5, 1.0, 1.0 and 2.0 μsec. Minimum delay 50 nsec.

INPUT

Front-panel BNC accepts ±10V; Z_{in} = 1KΩ, dc-coupled.

OUTPUT

Front-panel BNC connector provides ±10V max.; dc-coupled; Z_o = 50Ω.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 3 mA; +12 V, 8 mA
-24 V, 2 mA; -12 V, 9 mA

WEIGHT (SHIPPING) 5 lbs. (2.3 kg)
(NET) 2 lbs. 10 oz. (1.2 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

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TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 215 10.0K 1282

TENNELEC

TC 240
Amplifier

DESCRIPTION

The **TENNELEC TC 240** is a **general purpose, economical** amplifier in a single-width NIM module. The **low noise and high count rate** characteristics of the TC 240 are ideally suited for semiconductor detectors, proportional counters and scintillation detectors.

The TC 240 incorporates **four active integration networks** which generate the **near-Gaussian unipolar signals** expected in only the most expensive amplifiers. The pulse-shaping network is factory set for a **2.0 μsec peaking time** (1.0 μsec shaping constant). The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing excellent count rate capability (See Fig. 1).

An innovative **Base Line Restorer** (BLR) design provides superb high count rate performance without degrading peak resolution.

The **excellent dc stability** of the TC 240 eliminates spectrum broadening caused by dc shift of the amplifier output and insures superior performance.

The **bipolar output** signal is the true derivative of the unipolar output, i.e., the crossover of the bipolar signal occurs at the peak amplitude of the unipolar signal (See Fig. 2).

When used with TENNELEC preamplifiers, the TC 240 accepts signals from the preamplifier without any additional external cabling between the TC 240 and the preamplifier. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier cable and this eliminates the need for conventional cabling.

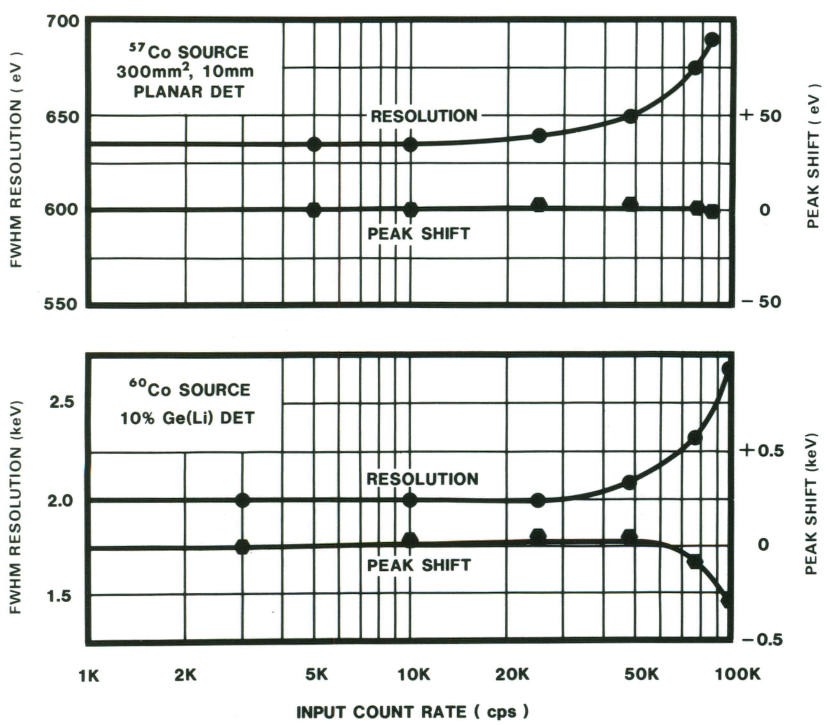
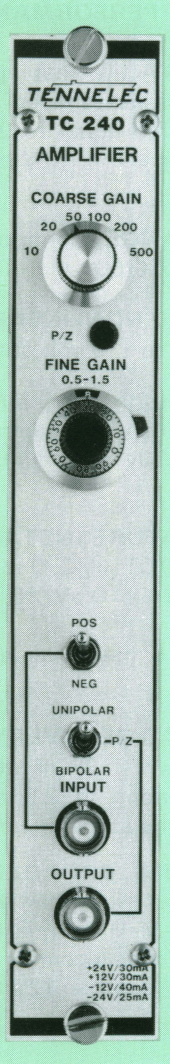


Figure 1
Resolution and Peak Shift vs Input Count Rate

- **Noise less than 5.0 μV**
- **Economical**
- **High count rate capability**
- **Four active integrator stages**
- **2.0 μsec peaking time**
- **Excellent dc stability**
- **Unipolar or bipolar output**



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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 240 Amplifier

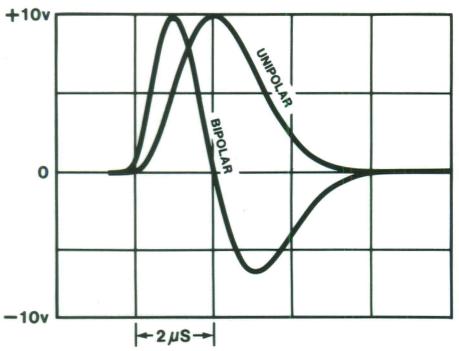


Figure 2
Output Pulse Shapes

SPECIFICATIONS

PERFORMANCE

SHAPING Active shaping networks produce Gaussian shaped pulses with a peaking time equal to 2.0 μsec and a pulse width at the 1.0% level equal to 5.6 μsec.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY ≤±0.05% over the 0 to +10 volt output range.

NOISE Less than 5.0 μV referred to the input for unipolar shaping at maximum gain. Typically less than 6.0 μV for gains ≥100.

TEMPERATURE INSTABILITY
Gain ≤±0.01%/°C, 0 to 50°C
DC Level ≤±10 μV/°C, 0 to 50°C

WALK ≤±5 nsec over a 50:1 dynamic range.

OVERLOAD RECOVERY (Unipolar) Recovers to within 2% of rated output from X300 overload in 2.5 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar)* Typically less than 4% FWHM for a ^{60}Co 1.33-MeV gamma line at 85% of full-scale for an incoming count rate of 1k to 50k cps, less than 12% for an incoming count rate of 75k cps.

SPECTRUM SHIFT (Unipolar)* Peak position shifts typically less than 0.01% for a ^{60}Co 1.33-MeV gamma line at 85% of full-scale for incoming count rates to 75k cps, less than 0.025% for incoming count rates of 100k cps.

OPERATING TEMPERATURE 0 to 50°C

*Results may not be reproducible if measurements are made with a detector which exhibits a large number of slow rise time signal components.

CONTROLS

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500, corresponding to multipliers of 0.5 and 1.5 respectively.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of preamplifier decay times from 30 μsec to infinity.

POS-NEG Toggle switch selects either positive or negative input pulse polarity.

UNI-P/Z-BI Toggle switch selects either unipolar or bipolar output pulses. The center position (PZ) disables the BLR circuit for accurate pole-zero concellation adjustment.

INPUT

INPUT BNC type front- and rear-panel connectors accept either positive or negative pulses with risetimes less than 700 nsec and decay times from 30 μsec to infinity; Z_{in} = 1000 ohms, dc-coupled.

OUTPUT

OUTPUT Front- and rear-panel BNC type connectors. Full-scale is 0 to +10V (+11.5V max.). A PCB mounted switch selects an output impedance of either <1 or 50 ohms. Outputs are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

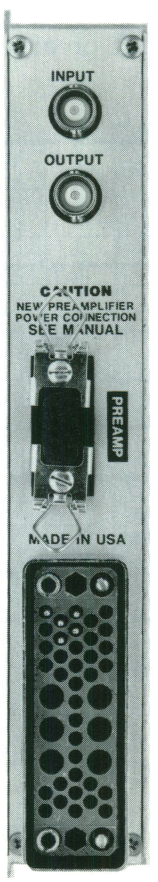
POWER REQUIREMENTS (excluding preamp)
+24V, 30 mA; +12V, 30 mA
−24V, 25 mA; −12V, 40 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.0 lbs. (0.9 kg)

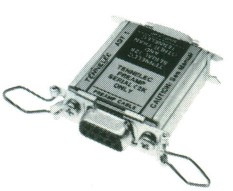
DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N <2000).



ADT 1



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 240 10.0K 1085

TENNELEC

TC 241
Amplifier

DESCRIPTION

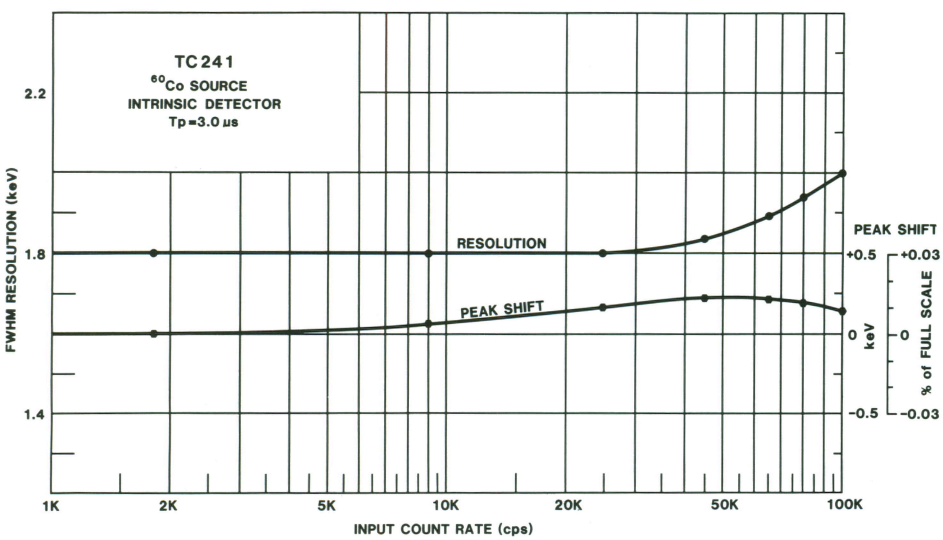
The TENNELEC Model TC 241 is a high performance, economical spectroscopy amplifier in a single-wide NIM module. The low noise and high count rate characteristics of the TC 241 are ideally suited for semiconductor detectors, proportional counters, and scintillation detectors.

The TC 241 incorporates four active integration networks which generate very symmetrical near-gaussian unipolar signals. **Switch selectable peaking times** of 1, 3, and 6 μsec (0.5, 1.5, and 3.0 μsec shaping times) allow the TC 241 to match the signal processing requirements of most detectors. The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing excellent count rate capability.

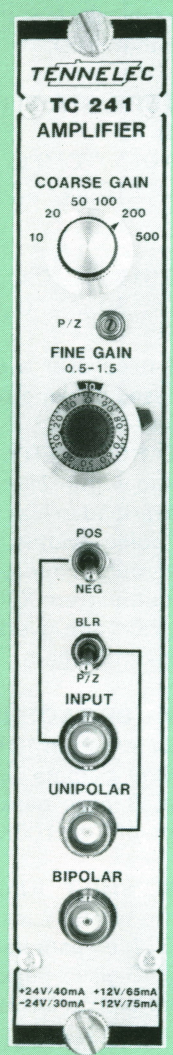
A **gated baseline restorer** (BLR) with **automatic threshold** and restorer rate circuits provides **superb high count rate performance** without degrading ultimate resolution.

The **excellent dc stability** of the TC 241 eliminates spectrum broadening often caused by dc shift of the amplifier output thus insuring superior performance.

An optional delay allows the unipolar output to be delayed by 2 μsec for gating applications.



- **Excellent dc stability**
- **Automatic BLR threshold control**
- **Gated baseline restorer**
- **High count rate capability**
- **Multiple shaping time constants**



SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active shaping networks produce near-gaussian shaped unipolar pulses with selectable peaking times (Tp) of 1, 3, or 6 μsec (0.5, 1.5, or 3.0 μsec shaping time). The unipolar pulse width is equal to 2.8 times the

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TC 241 Amplifier

selected peaking time. The bipolar pulse zero crossover is delayed from the prompt unipolar peak by 0.32 times the selected peaking time.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY
$\leqslant\pm0.05\%$ over 0 to +10V output range for 3 μsec peaking time.

NOISE Less than 3.0 μV referred to the input for 6 μsec peaking time, unipolar shaping, and maximum gain; typically less than 3.2 μV for gain greater than 100. Bipolar typically less than 5.0 μV for gain greater than 100.

TEMPERATURE STABILITY
UNIPOLAR
Gain $\leqslant\pm0.01\%/°C$, 0 to 50°C
DC Level $\leqslant\pm10$ μV/°C, 0 to 50°C

BIPOLAR
Gain $\leqslant\pm0.01\%/°C$, 0 to 50°C
DC Level $\leqslant\pm30$ μV/°C, 0 to 50°C

WALK $\leqslant\pm3$ nsec over a 50:1 dynamic range for 3 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X300 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X300 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar)* Typically less than 10% FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100K cps.

SPECTRUM SHIFT (Unipolar)* Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100K cps.

*Results may not be reproducible if measurements are made with a detector which exhibits an extremely large number of slow-risetime signal components.

OPERATING TEMP. 0 to 50°C

CONTROLS

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN controls extends the total gain range from 5 to 750.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of preamplifier decay times from 35 μsec to infinity.

POS-NEG Two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

BLR-P/Z Two-position toggle switch enables the baseline restorer in the BLR position. The P/Z position disables the baseline restorer for accurate pole-zero cancellation adjustment.

PEAKING TIME Four individual three-position slide switches (accessible through the module's side shield) select unipolar peaking times of 1, 3, or 6 μsec. Bipolar peaking time equals 0.78 of selected unipolar peaking time.

INPUT

INPUT Front- and rear-panel BNC type connectors accept either positive or negative pulses with risetimes less than the selected peaking time and decay times of 35 μsec to infinity. Z_{in} = 1000 ohms, dc coupled. Input protected to ±25 V max.

OUTPUT

UNIPOLAR Front- and rear-panel BNC type connectors. Full scale range of 0 to +10 V (+11.5 V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored and short-circuit protected.

BIPOLAR Front- and rear-panel BNC type connectors. Full scale range is 0 to +10 V (+11.5 V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamp)
+24 V, 40 mA; +12 V, 65 mA
−24 V, 30 mA; −12 V, 75 mA

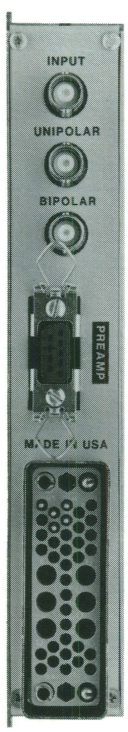
WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.5 lbs. (1.2 kg)

DIMENSIONS Standard single-wide NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year.

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifier.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 241 10.0K 584

TENNELEC

TC 242
Amplifier

DESCRIPTION

The **TENNELEC** Model **TC 242** incorporates the latest in high performance, improved technology, spectroscopy amplifier design in a single-width NIM module. The low noise, high count rate characteristics and wide range of peaking time constants make the **TC 242** the ideal choice for germanium and silicon semiconductor detectors, silicon charged particle detectors, scintillation detectors, proportional counters, or pulsed ion chambers.

The **TC 242** incorporates **eight active-filter networks** (six complex, two real) to generate **near-gaussian** shaped unipolar pulses with selectable peaking times of 1, 2, 4, 8, 16, and 24 μsec. (Peaking time is 2 times shaping time.) The unipolar pulse width measured at the 1% level is 2.45 times the selected peaking time for the **maximum signal-to-noise ratio.**

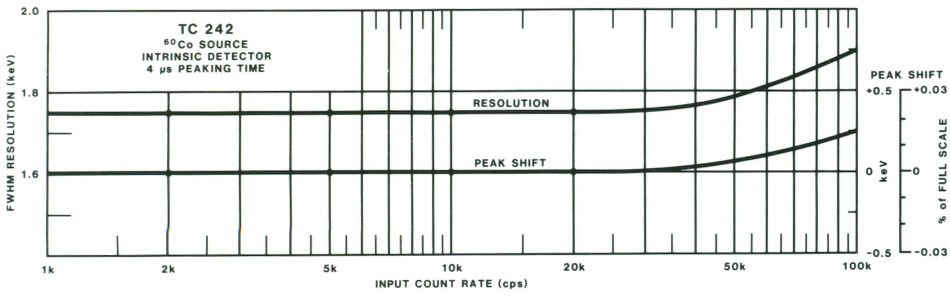
An automatic **gated baseline restorer** (BLR) with **automatic restoration rate** provides superb **high count rate performance without sacrificing resolution at low count rates**, while the **automatic threshold** adjusts as a function of input noise. The unipolar d.c. level is maintained at 0 ± 5 mV while the bipolar d.c. level is 0 ± 10 mV. A SYMmetrical and ASYMmetrical BLR switch is provided to further enhance resolution vs. count rate performance.

The excellent dc stability of the **TC 242 eliminates spectrum broadening** and **insures superior performance.**

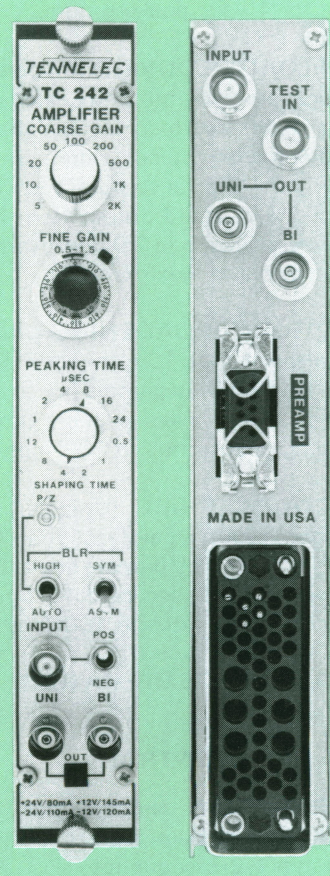
Improved **Overload Recovery** and **Spectrum Shift** result in consistent performance over wide input dynamic ranges.

An optional delay allows the unipolar output to be delayed by 2 μsec for gating applications.

When used with **TENNELEC** preamplifiers, the **TC 242** accepts signals from the preamplifier and supplies a test input pulse to the preamplifier without any additional external cabling between the **TC 242** and the preamplifier. Three high-quality RG-174 coaxial cables are incorporated into the **TENNELEC** preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need for conventional cabling.



- **Eight-pole active shaping network generates near-Gaussian pulses**
- **Gated BLR with automatic threshold**
- **Superior high and low count rate performance**
- **Excellent overload recovery and negligible spectrum broadening**
- **Accepts DIFFERENTIAL preamplifier signals**
- **Exclusive "one cable preamplifier connection"**



Front **Rear**

SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active eight-pole shaping network produces near-gaussian shaped unipolar pulses with selectable peaking times of 1, 2, 4, 8, 16, and 24 μsec. The unipolar pulse width measured at the 1% signal level equals 2.45 times the selected peaking time. The bipolar pulse zero-crossover is delayed from the prompt unipolar peak by 0.15 times the selected peaking time.

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TC 242 Amplifier

GAIN RANGE Continuously variable from X2.5 to X3000.

INTEGRAL NONLINEARITY ≤±0.04% over 0 to 10 volt output range for 4 μsec peaking time.

NOISE ≤4.0 μV rms referred to the input for 4 μsec peaking time, unipolar shaping and gain of 1000; typically ≤4.0 μV rms for gains ≥100. Bipolar typically ≤6.8 μV rms for 4 μsec peaking time and gains ≥100.

TEMPERATURE INSTABILITY

UNIPOLAR		
Gain	≤±0.0075%/°C, 0 to 50°C	
DC Level	≤±10	μV/°C, 0 to 50°C
BIPOLAR		
Gain	≤±0.0075%/°C, 0 to 50°C	
DC Level	≤±30	μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 4 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X1000 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X1000 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar) Typically less than 10% change of FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

SPECTRUM SHIFT (Unipolar) Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

COARSE GAIN Nine-position rotary switch selects gain factors from 5 to 2000 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN control extends the total gain range from 2.5 to 3000.

POLE-ZERO (P/Z) Multi-turn screwdriver adjustable control for cancellation of preamplifier decay times from 40 μsec to infinity.

HIGH-P/Z-AUTO Three-position toggle switch selects BLR restoration (slew) rate. The HIGH position provides a fixed high slew rate, while the AUTO position continuously adjust the slew rate as a function of input count rate for optimum performance. The P/Z position disables the BLR for accurate pole-zero cancellation adjustment.

SYM-ASYM Two-position toggle switch selects symmetrical or asymmetrical operation of the baseline restorer.

PEAKING TIME Six-position rotary switch selects unipolar peaking time of 1, 2, 4, 8, 16, or 24 μsec. A dual pointer knob indicates approximate shaping times of 0.5, 1, 2, 4, 8, and 12 μsec. Bipolar peaking time equals 0.77 times selected unipolar peaking time.

POS-NEG Two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

INPUT MODE Two-position slide switch (accessible through the module's side shield) selects either SINGLE-ENDED signals from the front- and rear-panel INPUT connectors or DIFFERENTIAL signals from the rear-panel PREAMP connector as the amplifier input signal source.

INPUTS

INPUT Front- and rear-panel BNC type connectors accept either positive or negative signals with rise times less than the selected peaking time and decay times of 40 μsec to infinity. The input impedance in the POS switch position is 500 ohms for COARSE GAIN settings of 10 or greater and 1050 ohms for COARSE GAIN setting of 5. The input impedance in the NEG switch position is 1500 ohms for COARSE GAIN settings of 10 or greater and 2050 ohms for COARSE GAIN setting of 5. The input is dc-coupled and protected to ±25 volts maximum.

TEST IN Rear-panel BNC type connector accepts test pulse inputs which are routed to TENNELEC preamplifiers through the preamplifier power cable.

OUTPUTS

UNI-OUT Front- and rear-panel BNC type connectors provide positive unipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored to 0 ±5 mV and short-circuit protected. A front-panel OUT LED indicator illuminates whenever an event (pulse) exceeds the unipolar BLR gate threshold.

BI-OUT Front- and rear-panel BNC type connectors provide positive lobe leading bipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0±10 mV and are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamplifiers)
+24 V, 80 mA; +12 V, 145 mA
−24 V, 110 mA; −12 V, 120 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.3 lbs. (1.1 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N < 2000).

OPTION The TC 242 may be ordered with a TC 242-02 option which delays the unipolar output by 2 μsec with respect to the input. A two-position internal slide switch selects either prompt (Out) or the 2 μsec delay (In) for the unipolar output.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018
TC 242 10.0K 286

TENNELEC

A 1125

TC 243
Amplifier

DESCRIPTION

The TENNELEC Model TC 243 is the first commercially available spectroscopy amplifier that gives you the choice of either **triangular** or **gaussian shaping** in a single-width NIM module. Based upon research conducted by the University of California Lawrence Berkeley Laboratories, triangular shaping gives intrinsically **better signal-to-noise ratios** and **superior high count rate performance.** The TC 243 is the new standard amplifier of choice for high resolution germanium and silicon semiconductor detectors, silicon charged particle detectors, scintillation detectors, proportional counters, and pulsed ion chambers.

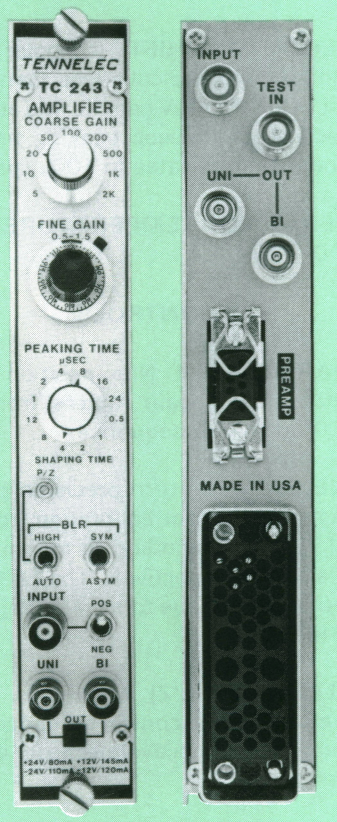
The TC 243 incorporates **eight-active filter networks** (six complex, two real) to generate **triangular** or **near-gaussian** shaped unipolar pulses with selectable peaking times of 1, 2, 4, 8, 16, and 24 μsec. (Peaking time is approximately 2 times shaping time for near-gaussian shaping and about 2.4 times shaping time for triangular shaping.) Selection of shaping mode is by a convenient slide switch accessible through the module side panel.

An automatic **gated baseline restorer** (BLR) with **automatic restoration rate** provides superb **high count rate performance without sacrificing resolution at low count rates**, while the **automatic threshold** adjusts as a function of input noise. The unipolar d.c. level is maintained at 0 ±5 mV while the bipolar d.c. level is 0 ±10 mV. A SYMmetrical and ASYMmetrical BLR switch is provided to further enhance resolution vs. count rate performance.

The excellent dc stability of the TC 243 **eliminates spectrum broadening** and **insures superior performance.**

Improved **Overload Recovery** and **Spectrum Shift** result in consistent performance over wide input dynamic ranges.

- **First commercially-available spectroscopy amplifier to offer either triangular or gaussian shaping**
- **Intrinsically better signal-to-noise ratios and superior high and low count rate performance**
- **Eight-pole active shaping network generates either triangular or gaussian pulses**
- **Gated BLR with automatic threshold**
- **Excellent overload recovery and negligible spectrum broadening**
- **Accepts DIFFERENTIAL signals from TENNELEC preamplifiers**



Front Rear

SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active eight-pole shaping network produces either triangular or near-gaussian shaped unipolar pulses with selectable gaussian peaking times of 1, 2, 4, 8, 16, and 24 μsec. Peaking times for triangular shaping are 1.20 times the gaussian peaking times. The unipolar pulse width measured at the 1% signal level equals 2.44 times the selected gaussian peaking time for gaussian shaping and 2.32 times the selected triangular peaking time for triangular shaping.

The bipolar pulse zero-crossover is delayed from the gaussian shaped unipolar peak by 0.15 times the selected gaussian peaking time.

GAIN RANGE Continuously variable from X2.5 to X3000.

INTEGRAL NONLINEARITY ≤±0.04% over 0 to 10 volt output range for 4 μsec peaking time.

NOISE ≤4.5 μV rms referred to the input for 4 μsec peaking time, gaussian unipolar shaping and gain of 1000; typically ≤4.0 μV rms for gains ≥100. Bipolar typically ≤6.8 μV rms for 4 μsec peaking time and gains ≥100.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 243 Amplifier

TEMPERATURE INSTABILITY

UNIPOLAR

Gain	≤±0.0075%/°C, 0 to 50°C	
DC Level	≤±10	μV/°C, 0 to 50°C

BIPOLAR

Gain	≤±0.0075%/°C, 0 to 50°C	
DC Level	≤±30	μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 4 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X1000 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X1000 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar) Typically less than 10% change of FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

SPECTRUM SHIFT (Unipolar) Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

COARSE GAIN Nine-position rotary switch selects gain factors from 5 to 2000 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN control extends the total gain range from 2.5 to 3000.

POLE-ZERO (P/Z) Multi-turn screwdriver adjustable control for cancellation of preamplifier decay times from 40 μsec to infinity.

HIGH-P/Z-AUTO Three-position toggle switch selects BLR restoration (slew) rate. The HIGH position provides a fixed high slew rate, while the AUTO position continuously adjust the slew rate as a function of input count rate for optimum performance. The P/Z position disables the BLR for accurate pole-zero cancellation adjustment.

SYM-ASYM Two-position toggle switch selects symmetrical or asymmetrical operation of the baseline restorer.

PEAKING TIME Six-position rotary switch selects gaussian unipolar peaking time of 1, 2, 4, 8, 16, or 24 μsec. A dual pointer knob indicates approximate equivalent SHAPING TIMES of 0.5, 1, 2, 4, 8, and 12 μsec. Triangular peaking time equals 1.2 times selected gaussian peaking time. Bipolar peaking time equals 0.75 times selected gaussian unipolar peaking time.

POS-NEG Two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

INPUT MODE Two-position slide switch (accessible through the module's side shield) selects either SINGLE-ENDED signals from the front- and rear-panel INPUT connectors or DIFFERENTIAL signals from the rear-panel PREAMP connector as the amplifier input signal source.

UNIPOLAR SHAPING MODE Two-position slide switch (accessible through the module's side shield) selects either Triangular or Gaussian shaping.

INPUTS

INPUT Front- and rear-panel BNC type connectors accept either positive or negative signals with risetimes less than the selected peaking time and decay times of 40 μsec to infinity. The input impedance in the POS switch position is 500 ohms for COARSE GAIN settings of 10 or greater and 1050 ohms for COARSE GAIN setting of 5. The input impedance in the NEG switch position is 1500 ohms for COARSE GAIN settings of 10 or greater and 2050 ohms for COARSE GAIN setting of 5. The input is dc-coupled and protected to ±25 volts maximum.

TEST IN Rear-panel BNC type connector accepts test pulse inputs which are routed to TENNELEC preamplifiers through the preamplifier power cable.

OUTPUTS

UNI-OUT Front- and rear-panel BNC type connectors provide positive unipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored to 0 ±5 mV and short-circuit protected. A front-panel OUT LED indicator illuminates whenever an event (pulse) exceeds the unipolar BLR gate threshold.

BI-OUT Front- and rear-panel BNC type connectors provide positive lobe leading bipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0±10 mV and are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamplifiers)
+24 V, 80 mA; +12 V, 145 mA
-24 V, 110 mA; -12 V, 120 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.3 lbs. (1.1 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 243 10.0K 9/85

TENNELEC

TC 244

Amplifier/Pileup Rejector Live Time Corrector

1295
2 year option #150

DESCRIPTION

The TENNELEC Model TC 244 represents the latest quantum technology breakthrough in the field of nuclear pulse spectroscopy. The TC 244 is the **first commercially available spectroscopy amplifier with triangular shaping and internal pulse pileup rejection.** A new technique of pileup rejection, based upon research conducted by the University of California Lawrence Berkeley Laboratories, enables the TC 244 to give up to 35% **higher throughput/count rate capability.** This breakthrough **dramatically reduces ADC deadtime at high counting rates.** Better pulse-pair resolution is obtained because the unipolar output pulse no longer must return to baseline before the pileup rejector resets. These features make the TC 244 the new standard amplifier of choice for the discriminating spectroscopist. The TC 244 is also useful for germanium planar and silicon x-ray detectors, silicon surface barrier detectors, scintillation detectors, proportional counters, and pulsed ion chambers. For any application requiring high throughput and maximum resolution, the TC 244 is the amplifier of choice.

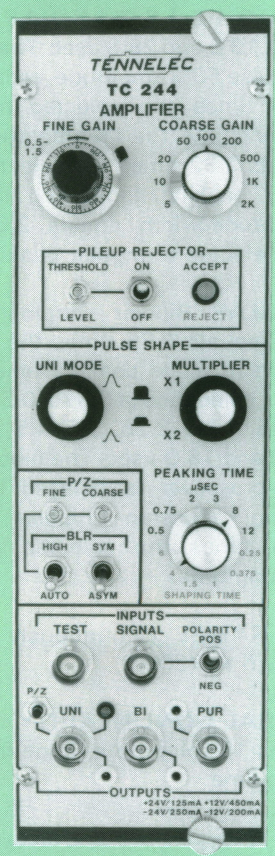
Twenty-four (24) front-panel selectable peaking times give the spectroscopist the ability to optimize resolution and throughput considerations. In addition, the TC 244 offers both **triangular and semi-gaussian pulse shaping.** For most applications the triangular shaping will give better results due to its wider output pulse and better signal-to-noise ratio.

An automatic **gated baseline restorer (BLR)** with **automatic restoration rate** provides high count rate performance without sacrificing resolution at low count rates, while the automatic threshold adjusts as a function of input noise. A SYMmetrical and ASYMmetrical BLR switch allows the user to optimize performance for detector systems having excessive noise, secondary preamplifier time constants, or pulsed reset preamplifiers.

LED indicators allow the user to verify performance of the TC 244 at a glance. TENNELEC's **exclusive bi-color pileup rejector LED** indicator appears green for 0 to approximately 40% pulse pileup rejection, yellow for 40-70% rejection, and red for 70% and above. The **Unipolar output LED** indicator illuminates to indicate signals are being processed through the amplifier.

The TC 244 **may be used with reset transistor or pulsed optical preamplifiers** without complicated interfaces or connections. When used with TENNELEC preamplifiers, the TC 244 accepts signals from the preamplifier and supplies a test input pulse to the preamplifier without any additional external cabling between the TC 244 and the preamplifier. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need for conventional cabling.

- **First commercially available spectroscopy amplifier with triangular shaping and internal pulse pileup rejection**
- **Higher throughput/count rate capability**
- **Dramatically reduces ADC deadtime at high counting rates**
- **Twenty-four (24) front-panel selectable peaking times**
- **Choice of triangular or semi-gaussian pulse shaping**
- **Gated baseline restorer (BLR) with automatic threshold and restoration rate**
- **Exclusive bi-color pileup rejector LED indicator**
- **Unipolar output LED indicator**
- **May be used with reset transistor or pulsed optical preamplifiers**
- **Exclusive "one cable preamplifier connection"**



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TC 244 Amplifier

SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active eight-pole shaping network produces either triangular or near-gaussian shaped unipolar pulses along with bipolar shaped pulses.

GAUSSIAN UNIPOLAR Selectable peaking times of 0.5, 0.75, 1, 1.5, 2, 3, 4, 6, 8, 12, 16 and 24 μsec are available in the gaussian mode. The gaussian pulse 50% amplitude-width equals the selected gaussian peaking time, the 1% amplitude-width equals 2.44 times the selected gaussian peaking time, and the 0.1% amplitude-width equals 2.89 times the selected gaussian peaking time.

TRIANGULAR UNIPOLAR Triangular shaping peaking time equals 1.20 times the selected gaussian mode peaking time, resulting in selections of 0.6, 0.9, 1.2, 1.8, 2.4, 3.6, 4.8, 7.2, 9.6, 14.4, 19.2 and 28.8 μsec. The triangular pulse 50% amplitude-width equals 1.05 times the selected triangular peaking time, the 1% amplitude-width equals 2.32 times the selected triangular peaking time, and the 0.1% amplitude-width equals 2.65 times the selected triangular peaking time.

BIPOLAR Bipolar shaping peaking time equals 0.75 times the selected gaussian mode peaking time, resulting in selections of 0.375, 0.563, 0.75, 1.125, 1.50, 2.25, 3.0, 4.5, 6.0, 9.0, 12.0 and 18.0 μsec. The bipolar pulse zero-crossover is delayed from the prompt gaussian unipolar peak by 0.15 times the selected gaussian peaking time.

GAIN RANGE Continuously variable from X2.5 to X3000.

INTEGRAL NONLINEARITY ≤±0.04% over 0 to 10 volt output range for 4 μsec peaking time.

NOISE ≤4.5 μV rms referred to the input for 4 μsec peaking time, gaussian unipolar shaping and gain of 1000; typically ≤4.0 μV rms for gains ≥100. Bipolar typically ≤6.8 μV rms for 4 μsec peaking time and gains ≥100.

TEMPERATURE INSTABILITY

UNIPOLAR
- Gain ≤±0.005%/°C, 0 to 50°C
- DC Level ≤±7.5 μV/°C, 0 to 50°C

PUR
- Gain ≤±0.007%/°C, 0 to 50°C
- DC Level ≤±50 μV/°C, 0 to 50°C

BIPOLAR
- Gain ≤±0.007%/°C, 0 to 50°C
- DC Level ≤±30 μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 4 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X1000 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X1000 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar) Typically less than 10% change of FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

SPECTRUM SHIFT (Unipolar) Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

PILEUP INSPECTOR RESOLVING TIME Typically 250 nsec.

LIVE TIME CORRECTION Typically less than +0/−10% change in ^{60}Co reference peak area in the presence of a 0 to 75k cps ^{137}Cs interfering source at 4 μsec peaking time.

LOSS FREE COUNTING MODE Provides real time compensation of amplifier, pileup rejector, and ADC counting losses when used with an external Loss Free Counting (LFC) module.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

COARSE GAIN Nine-position rotary switch selects gain factors from 5 to 2000 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN control extends the total gain range from 2.5 to 3000.

PILEUP REJECTOR

Threshold Level Multi-turn screwdriver adjustable control for setting the threshold level of the pulse pileup inspector. Variable from 0 to 1 volt.

On-Threshold-Off Three-position toggle switch selects pileup rejector mode. In the ON position the PUR output is enabled and the bicolor LED Accept/Reject indicator shows relative pileup rate. Threshold position disables the PUR output, DT output and the bi-color operation of the ACCEPT/REJECT indicator allowing the THRESHOLD control to be accurately adjusted by monitoring the red REJECT indicator. OFF totally disables both the PUR and ACCEPT/REJECT indicator.

UNI MODE Two-position pushbutton switch selects either semi-gaussian or triangular pulse shaping for the unipolar (UNI) output.

MULTIPLIER (X1-X2) Pushbutton switch extends the basic range of PEAKING TIMES by a factor of two.

POLE-ZERO (P/Z)

COARSE Multi-turn screwdriver adjustable control for cancellation of preamplifier decay times from 40 μsec to infinity.

FINE Multi-turn screwdriver adjustable control for precision cancellation of preamplifier decay times. The FINE control allows a 10% variation of the COARSE P/Z adjustment.

PEAKING TIME Six-position rotary switch selects gaussian unipolar peaking times of 0.5, 0.75, 2, 3, 8 and 12 μsec. A dual pointer knob indicates approximate equivalent SHAPING TIMES of 0.25, 0.375, 1, 1.5, 4 and 6 μsec. A X1-X2 MULTIPLIER doubles the range of gaussian peaking times. The triangular peaking time equals 1.20 times the selected gaussian peaking time, while the bipolar peaking time equals 0.75 times the selected gaussian peaking time.

POLARITY POS - NEG Two position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

P/Z Momentary contact pushbutton switch inserts a diode limiter in series with front-panel UNI connector and test point. Allows oscilloscope sensitivity to be increased without overload of the oscilloscope front end for accurate P/Z adjustment.

BASELINE RESTORER (BLR)

HIGH-P/Z-AUTO Three-position toggle switch selects BLR restoration (slew) rate. The HIGH position provides a fixed high slew rate, while the AUTO position continuously adjusts the slew rate as a function of input count rate for optimum performance. The P/Z position disables the BLR for accurate pole-zero cancellation adjustment.

SYM-ASYM Two-position toggle switch selects SYMmetrical or ASYMmetrical operation of the baseline restorer. ASYMmetrical operation provides a restoring current of three times the charging current to the BLR memory capacitor.

SINGLE ENDED - DIFFERENTIAL Rear-panel two-position locking toggle switch selects SINGLE ENDED inputs from front- and rear-panel SIGNAL IN connectors, or DIFFERENTIAL input through the rear-panel preamplifier connector.

INPUTS

SIGNAL Front- and rear-panel BNC type connectors or rear-panel preamplifier connector accept either positive or negative signals with risetimes less than the selected peaking time and decay times of 40 μsec to infinity. The input impedance in the POS switch position is 500 ohms for COARSE GAIN settings of 10 or greater and 1050 ohms for COARSE GAIN setting of 5. The input impedance in the NEG switch position is 1500 ohms for COARSE GAIN settings of 10 or greater and 2050 ohms for COARSE GAIN setting of 5. The input is dc-coupled and protected to ±25 volts maximum.

TEST Front- and rear-panel BNC type connectors accept test pulse inputs which are routed to TENNELEC preamplifiers through the preamplifier power cable.

ADC BUSY Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which indicate the ADC is available to process an event. Lost events are statistically corrected by extending live time. Internally selectable as active low or active high logic.

INHIBIT Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which disables the pileup rejector operation. Internally selectable as active low or active high logic.

OUTPUTS

UNI Front- and rear-panel BNC type connectors provide positive unipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored to 0 ±5 mV and short-circuit protected. A front-panel UNI indicator illuminates whenever an event (pulse) exceeds the unipolar BLR gate threshold.

BI Front- and rear-panel BNC type connectors provide positive lobe leading bipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0 ±10 mV and are short-circuit protected.

PUR Front- and rear-panel BNC type connectors provide a positive linear output whose amplitude equals the peak of the unipolar output. The PUR output pulses are near rectangular shape with a 0.4 μsec rise/fall time and a 50% amplitude-width of 1.5 μsec. Selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0 ±5 mV and are short-circuit protected.

DELAY When the unipolar delay option board is installed, the rear-panel BNC type connector provides a unipolar output which is delayed 2 μsec from the simultaneous prompt unipolar output. Selectable output impedance of either <1 ohm or 50 ohms. Output has a dc-level of 0 ±10 mV and is short-circuit protected.

ICR Rear-panel BNC type connector provides a 250 nsec wide positive NIM-standard logic pulse for each event which exceeds the pileup inspector threshold. Output impedance is 50 ohms, dc-coupled.

DT Rear-panel BNC type connector provides a logic signal to the ADC clock which provides statistical live time correction for the amplifier, pileup rejector and ADC by extending live time. Also functions with external Loss Free Counting (LFC) module to statistically correct for counting losses in real time. Positive NIM-standard logic output is internally selectable as active low or active high. Output impedance is 50 ohms, dc-coupled.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamplifier)
+24 V, 125 mA; +12 V, 450 mA
-24 V, 250 mA; -12 V, 200 mA

WEIGHT (SHIPPING) 8.0 lbs. (3.6 kg)
(NET) 5.0 lbs. (2.3 kg)

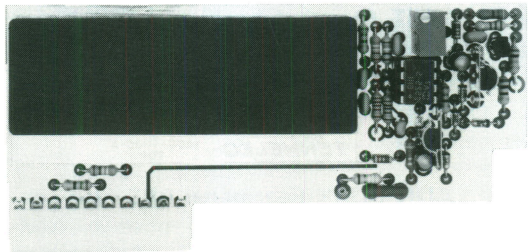
DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev).

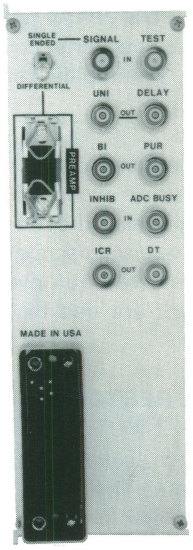
INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N <2000).

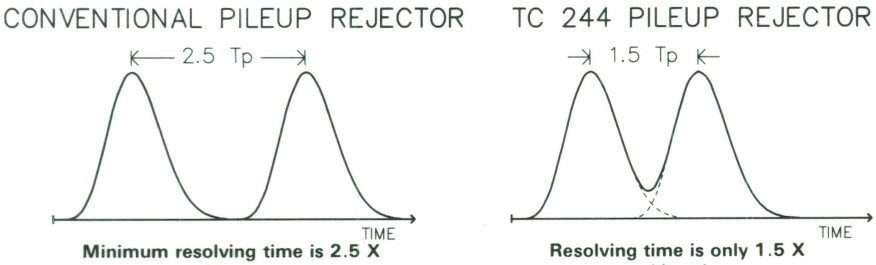
TC 244 Amplifier

OPTION The TC 244 may be ordered with a TC 244-02 option which provides a rear-panel delayed unipolar output that occurs 2 μsec after the simultaneous prompt unipolar output. This option is field-installable by the customer.





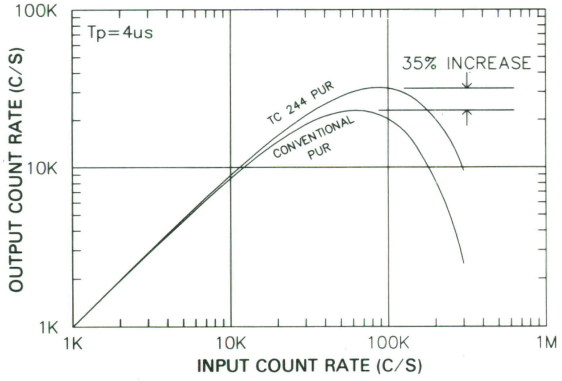
(Rear View)



TC 244 Improved Pulse Resolving Time

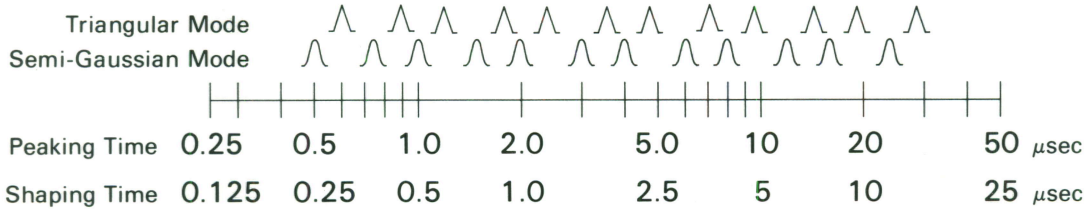
In a conventional amplifier with pulse pileup rejection, the minimum resolving time is limited to 2.5 times the peaking time. The trailing edge of the first pulse must return to the baseline before a second pulse begins; otherwise the second pulse will be rejected. This results in an excessive number of pulses being rejected and increases sample counting times.

The resolving time of the new TENNELEC TC 244 pileup rejector is only 1.5 times the peaking time. This means that if the peak of the second pulse occurs after the tail of the preceeding pulse would have returned to the baseline, then the second pulse will be accepted as a valid pulse. In the case of the TC 244, pulses may occur as close together as 1.5 times the peaking time selected and still be processed as valid pulses.



TC 244 Higher Throughput / Count Rate Capability

Because the TENNELEC TC 244 does not throw away as many pulses as conventional units, a dramatic improvement in throughput/count rate capability occurs. With a resolving time of 1.5 times the peaking time the TC 244 offers up to 35% increase in count rate capability.



TC 244 Twenty-Four (24) Time Constants for Optimum Resolution

Triangular and semi-gaussian pulse shaping allows selection of the best time constant to minimize parallel (step) and series (delta) noise.

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TC 244 10.0K 1185

TENNELEC

TC 246
Amplifier and Single Channel Analyzer

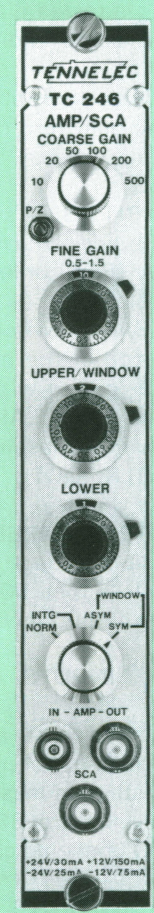
DESCRIPTION

The TC 246 Amplifier section incorporates **four active integration networks** which generate the **near-Gaussian unipolar signals** expected in only the most expensive amplifiers. The pulse-shaping network is factory set for a **2.0 μsec peaking time** (1.0 μsec shaping constant). The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing excellent count rate capability. An innovative **Base Line Restorer** (BLR) design provides superb high count rate performance without degrading peak resolution. The **excellent dc stability** eliminates spectrum broadening caused by dc shift of the amplifier output and insures superior performance. The **bipolar output** signal is the true derivative of the unipolar output, i.e., the crossover of the bipolar signal occurs at the peak amplitude of the unipolar signal.

The TC 246 Single Channel Analyzer section has **four basic modes of operation.** In the **integral (INTG) mode**, an output signal is generated if the linear output pulse amplitude exceeds the lower level threshold. In the **normal (NORM) mode**, the SCA provides an output pulse if the linear output pulse amplitude exceeds the lower level but does not exceed the upper level setting. In this mode, both lower level and upper level thresholds are adjustable from 20 mV to 10 V. In the **asymmetrical (ASYM) window mode**, the SCA operates as a high-resolution, narrow (0 to 10%) window single channel analyzer. In the **symmetrical (SYM) window mode**, the window adjustment increases symmetrically above and below the lower level threshold, allowing the operator to set the window quickly and easily at the full width half maximum (FWHM), full width tenth maximum (FWTM) positions, etc. Through the use of a separate lower level (LL) output and upper level (UL) output, the unit can operate as a dual wide-dynamic range integral discriminator for pulse routing.

When used with TENNELEC preamplifiers, the TC 246 accepts signals via three high-quality RG-174 coaxial cables incorporated into the TENNELEC preamplifier power cable. Our exclusive "one cable preamplifier connection" eliminates the need and expense of conventional BNC cabling.

- **NIM-standard Single Width Module**
- **Amplifier**
  - **Noise <5 μV**
  - **Four Active Integrator Stages**
  - **2.0 μsec Peaking Time**
  - **Unipolar or Bipolar Output**
- **Single Channel Analyzer**
  - **Four Operational Modes:**
    - **Integral**
    - **Normal**
    - **Asymmetrical Window**
    - **Symmetrical Window**
  - **SCA, UL and LL Outputs**
- **High Count Rate Capability**
- **Excellent DC Stability**
- **Exclusive "one cable preamplifier connection"**



SPECIFICATIONS

AMPLIFIER

PERFORMANCE

SHAPING Active shaping networks produce Gaussian shaped pulses with a peaking time equal to 2.0 μsec and a pulse width at the 1.0% level equal to 5.6 μsec.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY ≤0.05% over the 0 to 10 volt output range.

NOISE Less than 5.0 μV referred to the input for unipolar shaping at maximum gain. Typically less than 6.0 μV for gains ≥100.

TEMPERATURE INSTABILITY
Gain ≤0.01%/°C, 0 to 50°C
DC Level ≤10 μV/°C, 0 to 50°C

WALK ≤5 nsec over a 50:1 dynamic range.

OVERLOAD RECOVERY Recovers to within 2% of rated output from X300 overload in less than 2.5 non-overloaded pulse widths using maximum gain and unipolar shaping.

SPECTRUM BROADENING* Typically less than 4% FWHM for a ^{60}Co 1.33-MeV gamma line at 85% of full scale for an incoming count rate of 1 K to 50 K cps.

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TC 246 Amplifier and Single Channel Analyzer

Less than 12% for an incoming count rate of 75 K cps. Unipolar output, 2 μsec peaking time.

SPECTRUM SHIFT* Peak position shifts typically less than 0.01% for a ^{60}Co 1.33-MeV gamma line at 85% of full scale for incoming count rates to 75 K cps and less than 0.025% for incoming count rates to 100 K cps. Unipolar output, 2 μsec peaking time.

OPERATING TEMPERATURE 0 to 50°C

* Results may not be reproducible if measurements are made with a detector which exhibits a large number of slow rise time signal components.

CONTROLS

COARSE GAIN Six-position switch selects gain factors of 10, 20, 50, 100, 200 and 500.

FINE GAIN Ten-turn precision potentiometer with graduated dial for continuously variable direct-reading gain factor of X0.5 to X1.5.

P/Z Screwdriver adjustable potentiometer to set the pole-zero cancellation to compensate input decay times from 30 μsec to infinity.

INPUT POLARITY Slide switch accessible through the side of the module selects either positive (POS) or negative (NEG) input pulse polarity.

SHAPING Slide switch accessible through the side of the module selects either unipolar output with active baseline restoration (UNIPOLAR-BLR IN), unipolar output without baseline restoration (UNIPOLAR-BLR OUT), or BIPOLAR output.

LINEAR OUTPUT IMPEDANCE Slide switch accessible through the side of the module selects either 50 ohms or <1 ohm amplifier output impedance.

INPUTS

AMP IN BNC type front- and rear-panel connectors accept either positive or negative pulses with risetimes less than 700 nsec and decay times of 30 μsec to infinity; Z_{in} = 2000 ohms, dc coupled.

OUTPUTS

AMP OUT Front- and rear-panel BNC type connectors. A PCB mounted switch selects an output impedance of either 50 ohms or <1 ohm.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers. Earlier TENNELEC preamplifiers require a model ADT 1 power adapter.

SINGLE CHANNEL ANALYZER

PERFORMANCE

DYNAMIC RANGE 500:1

PULSE PAIR RESOLVING TIME 100 nsec plus output pulse width.

THRESHOLD TEMPERATURE INSTABILITY ≤0.01%/°C of full scale, 0 to 50°C.

WINDOW WIDTH CONSTANCY <0.1% variation of full scale window width over the linear 0 to +10 V range.

DISCRIMINATOR NONLINEARITY <±0.25% of full scale (integral) for both discriminators.

OUTPUT PULSE WIDTH 500 nsec.

CONTROLS

UPPER/WINDOW Front-panel 10-turn potentiometer determines the window width (0 to +1 V) in the window modes or the upper level (0 to +10 V) threshold in the Normal mode.

LOWER Front-panel 10-turn potentiometer adjustable from 20 mV to +10 V determines the threshold setting for the lower level disciminator.

NORM/INTG/WINDOW ASYM/WINDOW SYM Front-panel four-position rotary switch selects one of four operating modes:

Normal LL and UL are independently adjustable (20 mV to +10 V); differential mode is operative.

Integral LL and UL are independently adjustable (20 mV to +10 V); the UL response is ignored for the SCA OUTPUT.

Asymmetrical Window LL sets the baseline level (20 mV to +10 V) and UL sets the window width (0 to 1 V); differential mode is operative.

Symmetrical Window LL sets the centroid level (20 mV to +10 V) and the UL sets the window width which is symmetrical about the LL (0 to 1 V). Differential mode is operative with the lower level discriminator equal to the LL value −½ window width; the upper level discriminator is equal to the LL value +½ window width.

OUTPUTS

UL Rear-panel BNC connector provides positive NIM-standard outputs, nominally +5 V; 500 nsec wide; Z_0 = 50 ohm. Output occurs when the leading edge of the linear output crosses the upper level or window threshold.

SCA Front- and rear-panel BNC connectors provide positive NIM-standard outputs, nominally +5 V; 500 nsec wide; Z_0 = 50 ohm. Output occurs when operating mode conditions are met and the trailing edge of the linear output crosses the lower level threshold.

LL Rear-panel BNC connector provides positive NIM-standard output nominally +5 V; 500 nsec wide; Z_0 = 50 ohm. Output occurs as the leading edge of the linear output crosses the lower level threshold.

ORDERING INFORMATION

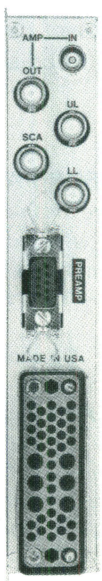
POWER REQUIRED (excluding preamp)
+24 V, 30 mA; +12 V, 150 mA
−24 V, 25 mA; −12 V, 75 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 3.0 lbs. (1.4 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N <2000).



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 246 10.0K 985

TENNELEC

TC 247
Dual Amplifier

DESCRIPTION

The TENNELEC TC 247 contains **two general purpose amplifiers in one economical single-wide NIM module.** The **low noise and high count rate** characteristics of the TC 247 are ideally suited for semiconductor detectors, proportional counters and scintillation detectors.

Each amplifier incorporates **four active integration networks** which generate the **near-Gaussian unipolar signals** expected in only the most expensive amplifiers. The pulse-shaping network is factory set for **2.0 μsec peaking time** (1.0 μsec shaping constant). The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing **excellent count rate capability** (See Fig. 1).

An innovative **Base Line Restorer** (BLR) design provides superb high count rate performance without degrading peak resolution.

The **excellent dc stability** of the TC 247 eliminates spectrum broadening caused by dc shift of the amplifier output and insures superior performance.

The **bipolar output** signal is the true derivative of the **unipolar output**; i.e., the crossover of the bipolar signal occurs at the peak amplitude of the unipolar signal (See Fig. 2).

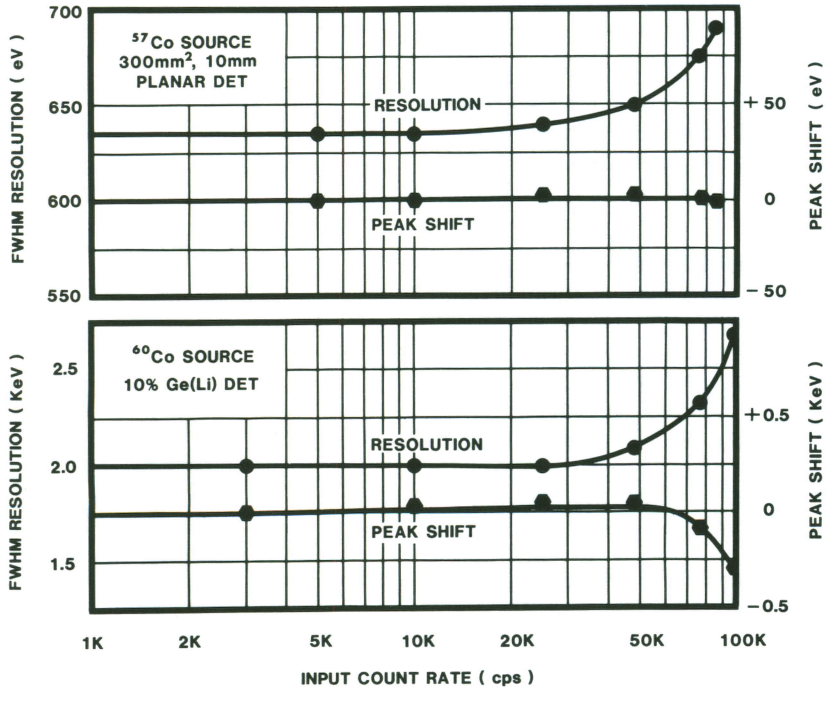
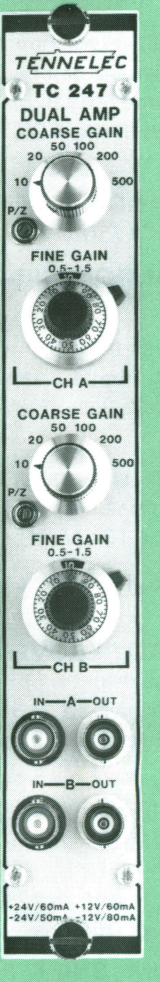


Figure 1
Resolution and Peak Shift vs Input Count Rate

- **Two amplifiers in one single-wide NIM module**
- **Noise less than 5.0 μV**
- **Economical**
- **High count rate capability**
- **Four active integrator stages**
- **2.0 μsec peaking time**
- **Excellent dc stability**
- **Unipolar or bipolar output**



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 247 Dual Amplifier

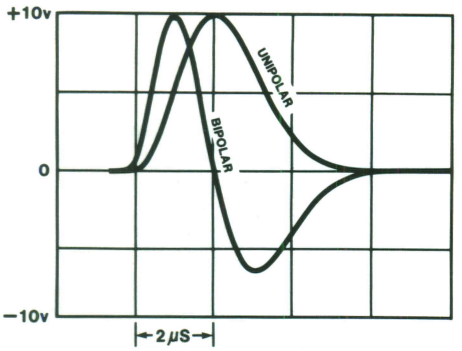


Figure 2
Output Pulse Shapes

SPECIFICATIONS

The following PERFORMANCE, CONTROL and CONNECTOR specifications apply to each amplifier channel.

PERFORMANCE

SHAPING Active shaping networks produce Gaussian shaped pulses with a peaking time equal to 2.0 μsec and a pulse width at the 1.0% level equal to 5.6 μsec.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY ≤0.05%, 0 to +10 V.

NOISE Less than 5.0 μV referred to the input for unipolar shaping at maximum gain, typically less than 6.0 μV for gains ≥100.

TEMPERATURE INSTABILITY
Gain ≤0.01%/°C, 0 to 50°C
DC level ≤10 μV/°C, 0 to 50°C

WALK ≤5 nsec over a 50:1 dynamic range.

OVERLOAD RECOVERY (Unipolar) Recovers to within 2% of rated output from X300 overload in 2.5 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar)* Typically less than 4% FWHM for a ^{60}Co 1.33-MeV gamma line at 85% of full-scale for an incoming count rate of 1k to 50k cps, less than 12% for an incoming count rate of 75k cps.

SPECTRUM SHIFT (Unipolar)* Peak position shifts typically less than 0.01% for a ^{60}Co 1.33-MeV gamma line at 85% of full-scale for incoming count rates to 75k cps, less than 0.025% for incoming count rates of 100k cps.

OPERATING TEMPERATURE 0 to 50°C

*Results may not be reproducible if measurements are made with a detector which exhibits a large number of slow-risetime signal components.

CONTROLS

(Identical for both amplifier sections)

FRONT PANEL

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500, corresponding to multipliers of 0.5 and 1.5 respectively.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of preamplifier decay times from 30 μsec to infinity.

INTERNAL

INPUT POLARITY Two-position slide switch (accessible through the module's side shield) selects either positive (POS) or negative (NEG) polarity preamplifier signals for the amplifier input.

SHAPING Three-position slide switch (accessible through the module's side shield) selects UNIPOLAR-BLR IN, UNIPOLAR-BLR OUT or BIPOLAR output pulse shaping.

OUTPUT IMPEDANCE Two-position slide switch (accessible through the module's side shield) selects an output impedance of either <1 ohm or 50 ohms for both front- and rear-panel OUT connectors. The total peak output current is limited to 50 mA when operated in the <1 ohm position. The outputs are short circuit protected in either OUTPUT IMPEDANCE position.

CONNECTORS

(Identical for both amplifier sections)

IN Front- and rear-panel BNC connectors accept either positive or negative signals with risetimes of less than 700 nsec and decay times of 30 μsec to infinity. The input impedance is 2000 ohms dc-coupled and protected to ±25 V absolute maximum.

OUT Front- and rear-panel BNC connectors provide either unipolar or bipolar shaped output pulses as selected by the SHAPING switch. The output is dc restored (0 V ± 5 mV) and has a full-scale linear range of 0 to +10 V (+11.5 V maximum).

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers. TENNELEC preamplifiers with serial numbers less than 2000 require a model ADT-1 Preamp Power Adapter.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamplifiers)
+24 V, 60 mA; +12 V, 60 mA
−24 V, 50 mA; −12 V, 80 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.5 lbs. (1.1 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED Two model ADT-1 PREAMP POWER ADAPTERS.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 247 10.0K 584

TENNELEC

TC 248
Fast/Slow Amplifier

DESCRIPTION

The **TENNELEC** Model **TC 248** is both a high performance **spectroscopy amplifier** and a **timing filter amplifier** in a single-width NIM module. It is ideally suited for **large silicon surface barrier detector arrays** and other applications where both spectroscopy and timing/coincidence information are required. The low noise spectroscopy amplifier section may be used alone for semiconductor detectors, proportional detectors, and scintillation detectors at high and low count rates.

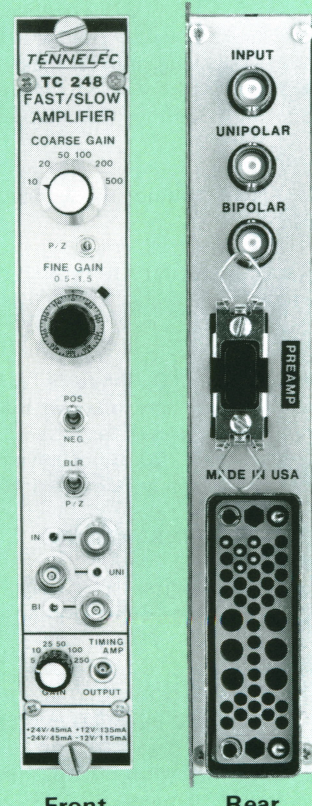
The timing filter amplifier has **separate integration/differentiation time constants, coarse gain** switch, and a **rise time** of less than **10 nanoseconds.** The linear output amplitude range is from 0 to −5 volts into 50 ohms.

The spectroscopy amplifier incorporates four active integration networks which generate very symmetrical near-gaussian **unipolar** signals. **Bipolar** signals are also available as a separate output. **Switch selectable peaking times** of 1, 3, and 6 μsec (0.5, 1.5, and 3.0 μsec shaping times) allow the **TC 248** to match the signal processing requirements of most detectors. The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing excellent count rate capability. A **gated baseline restorer** (BLR) with **automatic threshold** and restorer rate circuits provides **superb high count rate performance** without degrading ultimate resolution. The **excellent dc stability** of the **TC 248** eliminates spectrum broadening often caused by dc shift of the amplifier output thus insuring superior performance.

TENNELEC preamplifier power cables have an **integral, high-quality coaxial signal cable** that **eliminates** the need for a separate BNC cable between the preamplifier and amplifier. The **TC 248** has selectable output impedance of either <1 ohm or 50 ohms.

An optional delay allows the unipolar output from the spectroscopy amplifier to be delayed by 2 μsec for gating applications.

- **Timing Filter Amplifier and Spectroscopy Amplifier in a single-width NIM module**
- **Timing Filter Amplifier:**
  - **Separate integration/differentiation time constants**
  - **Coarse gain switch, X5-X250**
  - **Rise time <10 nsec**
- **Spectroscopy Amplifier:**
  - **Gated baseline restorer with automatic threshold control**
  - **High count rate capability**
  - **Multiple shaping time constants**
  - **Unipolar and Bipolar Outputs**
  - **"One cable preamplifier connection"**



Front Rear

SPECIFICATIONS

TIMING FILTER AMPLIFIER PERFORMANCE

INPUT AMPLITUDE RANGE 0 to ±1 volt linear signal; 0 to ±3.5 volts dc; maximum input (signal plus dc) ±4.5 volts.

OUTPUT AMPLITUDE RANGE 0 to −5 volts linear into a 50 ohm load.

RISETIME Typically ≤ 10 nsec with minimum integration and maximum differentiation.

GAIN TEMPERATURE INSTABILITY <±0.1%/°C, 0 to 50°C

CONTROLS

FRONT-PANEL CONTROL

GAIN Six-position rotary switch selects gain factors from 5 to 250 in a 1-2.5-5 sequence.

INTERNAL CONTROLS
(Accessible through the module's side shield)

INPUT POLARITY Two-position slide switch selects either positive or negative polarity preamplifier signals for the timing amplifier input.

DIFFERENTIATOR TIME CONSTANT Four individual two-position slide switches select differentiator time constants of 10, 20, 50, and 100 nsec. Switches may be used in combination to provide intermediate time constants, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. All switches OUT provides a 5 nsec time constant.

INTEGRATOR TIME CONSTANT Four individual two-position slide switches select integrator time constants of 10, 20, 50, and 100 nsec. Switches may be used in combination to provide intermediate time constants, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. The rise time is approximately 2.2 times the selected time constant.

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 248 FAST/SLOW AMPLIFIER

INPUT

COMMON INPUT Front- and rear-panel BNC type connectors accept either positive or negative pulses with rise times less than the selected peaking time and decay times of 35 μsec to infinity. The input impedance is 50 ohms dc-coupled, and the input is protected to ±4.5 volts absolute maximum.

NOTE: The **INPUT** is common to both the Timing Filter and Spectroscopy Amplifiers.

OUTPUT

OUTPUT Lemo type connector provides shaped timing output pulses with a full-scale linear range of 0 to −5 volts (−7 volts maximum) when terminated into a 50 ohm load. Rise time and decay time selected by the **DIFFERENTIATOR** and **INTEGRATOR** switch settings.

SPECTROSCOPY AMPLIFIER

PERFORMANCE

PULSE SHAPING Active shaping networks produce near-gaussian shaped unipolar pulses with selectable peaking times (Tp) of 1, 3, or 6 μsec (0.5, 1.5, or 3.0 μsec shaping time). The unipolar pulse width is equal to 2.8 times the selected peaking time. The bipolar pulse zero crossover is delayed from the prompt unipolar peak by 0.32 times the selected peaking time.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY ≤±0.05% over 0 to +10V output range for 3 μsec peaking time.

NOISE Less than 3.0 μV referred to the input for 6 μsec peaking time, unipolar shaping and maximum gain; typically less than 3.2 μV for gain greater than 100. Bipolar typically less than 5.0 μV for gain greater than 100.

TEMPERATURE INSTABILITY

UNIPOLAR
- Gain ≤±0.01%/°C, 0 to 50°C
- DC Level ≤±10 μV/°C, 0 to 50°C

BIPOLAR
- Gain ≤±0.01%/°C, 0 to 50°C
- DC Level ≤±30 μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 3 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X300 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X300 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar)* Typically less than 10% FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100k cps.

SPECTRUM SHIFT (Unipolar)* Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100k cps.

*Results may not be reproducible if measurements are made with a detector which exhibits an extremely large number of slow-rise time signal components.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

FRONT-PANEL CONTROLS

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500. The dial numbers should be considered as multipliers operating on the COARSE GAIN setting, with 500 and 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN controls extends the total gain range from 5 to 750.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of preamplifier decay times from 35 μsec to infinity.

POS-NEG Two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

BLR-P/Z Two-position toggle switch enables the baseline restorer in the BLR position. The P/Z position disables the baseline restorer for accurate pole-zero cancellation adjustment.

INTERNAL CONTROLS
(Accessible through the module's side shield)

PEAKING TIME Four individual three-position slide switches select unipolar peaking times of 1, 3, or 6 μsec. Bipolar peaking time equals 0.78 of selected unipolar peaking time.

OUTPUT IMPEDANCE Individual two-position slide switches selects an output impedance of either <1 ohm or 50 ohms for the UNIPOLAR and BIPOLAR outputs. All outputs are short circuit protected in either position.

INPUT

COMMON INPUT Front- and rear-panel BNC type connectors accept either positive or negative pulses with rise times less than the selected peaking time and decay times of 35 μsec to infinity. Z_{in} = 50 ohms, dc-coupled. Input protected to ±4.5 volts maximum.

OUTPUTS

UNIPOLAR Front- and rear-panel BNC type connectors. Full-scale range of 0 to +10V (+11.5V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored and short-circuit protected.

BIPOLAR Front- and rear-panel BNC type connectors. Full-scale range of 0 to +10V (+11.5V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

TENNELEC preamplifier power cables contain an internal coaxial cable which establishes a signal connection between the preamplifier output and amplifier input, thus eliminating the need for a separate external BNC signal cable.

ORDERING INFORMATION

POWER REQUIREMENTS *(excluding preamp)*

+24 V, 45 mA; +12 V, 135 mA
−24 V, 45 mA; −12 V, 115 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.5 lbs. (1.2 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

OPTION The TC 248 may be ordered with a TC 248-02 option which delays the unipolar output by 2 μsec with respect to the input. A two-position internal slide switch selects either prompt (Out) or the 2 μsec delay (In) for the unipolar output.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 248 10.0K 286

TENNELEC

TC 252
Biased Amplifier

DESCRIPTION

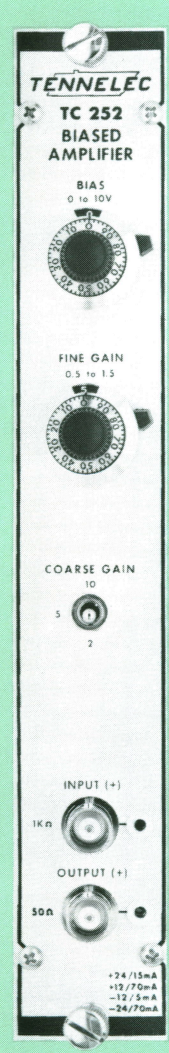
The TENNELEC TC 252 Biased Amplifier is a single-width NIM module and accepts unipolar or bipolar signals from any commercially available linear amplifier. Its purpose is to permit **spectrum expansion** of a region of interest to allow maximum utilization of existing multichannel analyzers in high-resolution applications.

The TC 252 features **extremely good temperature and gain stability** and is **dc-coupled** throughout for high counting rates.

The linearity of the unit is preserved to within millivolts of the bias threshold and the bias threshold can be adjusted to zero volts.

Post gain above the bias level is **continuously variable** from X1 through X15 by a Coarse Gain switch and a 10-turn Fine Gain control.

- **Dc-coupled for high count rate**
- **Excellent temperature and gain stability**
- **Spectrum expansion**
- **Continuously adjustable gain**



SPECIFICATIONS

PERFORMANCE

INTEGRAL NONLINEARITY $< 0.1\%$

TEMPERATURE INSTABILITY
GAIN $< \pm 0.01\%/^{\circ}C$
BIAS LEVEL $< 0.01\%/^{\circ}C$

NOISE $\leqslant 15\ \mu V$

SIGNAL FEEDTHROUGH $< 0.1\%$

CONTROLS

BIAS Front-panel 10-turn potentiometer adjustable from 0 to 10 V.

FINE GAIN Front-panel 10-turn potentiometer adjust gain from X0.5 to X1.5.

COARSE GAIN Front-panel, 3-position toggle switch selects gain of X2, X5, or X10; total gain is a product of Fine and Coarse Gain controls.

INPUTS

INPUT (+) Front-panel BNC connector accepts positive unipolar or bipolar pulses from 0.1 to 10 V; minimum shaping time 0.4 μsec (RC); Z_{in} = 1K Ω, dc-coupled.

OUTPUTS

OUTPUT (+) Front-panel BNC connector provides linear output 0 to +10 V; +12 V maximum; Z_o = 50 Ω.

ORDERING INFORMATION

POWER REQUIRED
+ 24V, 15 mA; + 12V, 70 mA
− 24V, 70 mA; − 12V, 5 mA

WEIGHT (SHIPPING) 5 lbs (2.2 kg)
(NET) 3 lbs (1.3 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

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TENNELEC INC.
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TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 252 10.0K 985

TENNELEC

TC 253
Dual Sum and Invert Amplifier

DESCRIPTION

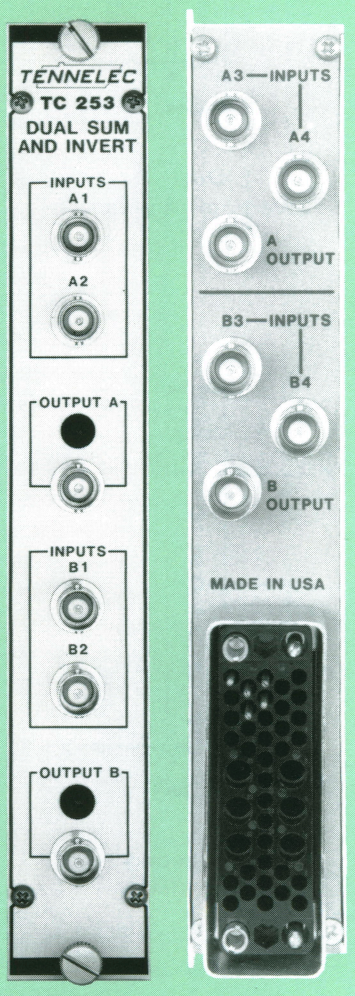
The **TENNELEC TC 253** Dual Sum and Invert Amplifier is a single-width NIM module designed for high performance summing and inverting applications.

The **TC 253** incorporates two wide-band, inverting, unity-gain amplifiers, Amplifier A and Amplifier B each having four summing inputs. If non-inverting outputs are required, Amplifier A can be cascaded with Amplifier B to form a 4-input, non-inverting amplifier.

The output of each amplifier has an LED count-indicator which provides a visual indication that the instrument is processing pulses. Output connectors for each amplifier are duplicated on the front and rear panel.

The wide bandwidth and dynamic range make the **TC 253** ideal for summing and/or inverting of standard NIM signals or DC levels.

- **Two independent, four-input summing amplifiers**
- **Wide dynamic range, 0 to ±10 V**
- **Wide bandwidth, d.c. to 10 MHz**
- **LED count indicator**
- **Low noise, <5 μV rms**



Front Rear

SPECIFICATIONS

PERFORMANCE

VOLTAGE GAIN Inverting, unity-gain for each input; tolerance ⩽ ±2%

DYNAMIC RANGE Linear range of ±10 V; saturates at ±15 V.

BANDWIDTH dc to 10 MHz (t_r ⩽35 ns)

INTEGRAL NONLINEARITY ⩽0.05% of full rated output

TEMPERATURE INSTABILITY

Gain	⩽ ±0.005%/°C
DC Level	⩽ ±25 μV/°C

NOISE Typically contributes less than 5 μV rms when operated ahead of a TC 243 amplifier set for 4 μs peaking time.

OPERATING TEMPERATURE 0 to 50°C

INPUTS

Four independent BNC-type input connectors for both Amplifier A and Amplifier B accept 0 to ± 10 V unipolar or bipolar signals, Z_{in} = 1k ohm, DC coupled. Inputs A1, A2, B1, and B2 are located on the front panel. Inputs A3, A4, B3, and B4 are located on the rear panel.

OUTPUTS

Two outputs are provided for each amplifier. One BNC connector is located on the front panel and one on the rear panel; Z_o = 50 ohm or <1 ohm, selected via a PCB mounted switch; Range 0 to ±10 V.

A front-panel output LED indicator illuminates whenever an event (pulse) exceeds the fixed input threshold of ±250 mV.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 60 mA; +12 V, 30 mA
−24 V, 60 mA; −12 V, 15 mA

WEIGHT (SHIPPING) 5 lbs. (2.3 kg)
(NET) 2 lbs. (0.9 kg)

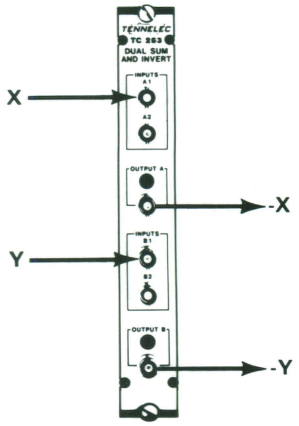
DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

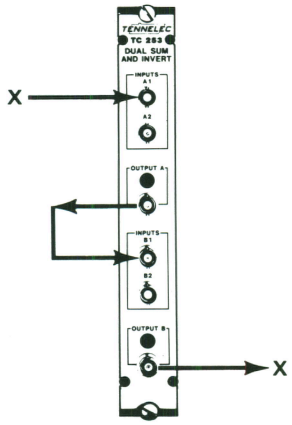
TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

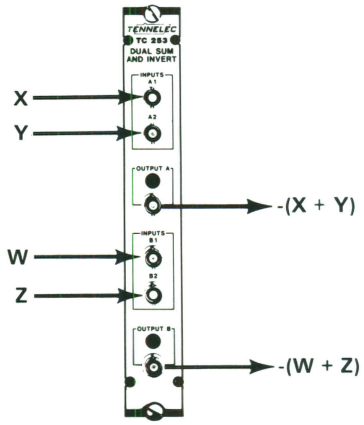
TYPICAL APPLICATIONS Illustrations of some possible applications are presented below. They may be expanded to include three and/or four inputs, and any combination is also possible.



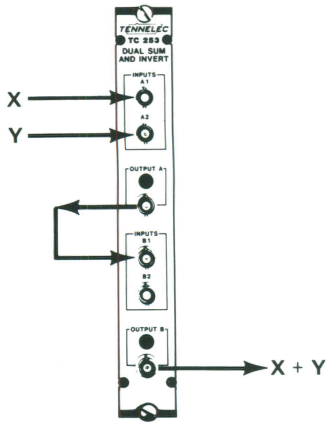
Dual Inverting Amplifier



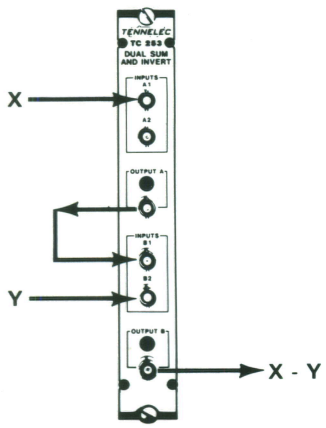
Non-Inverting Buffer Stage



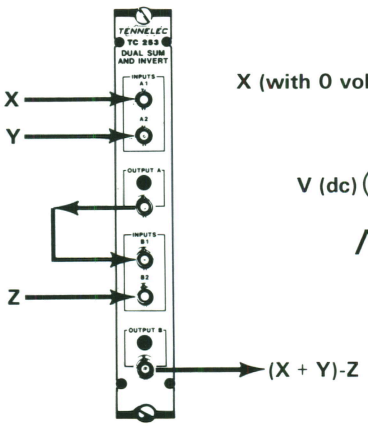
Dual Summing Inverting Amplifier



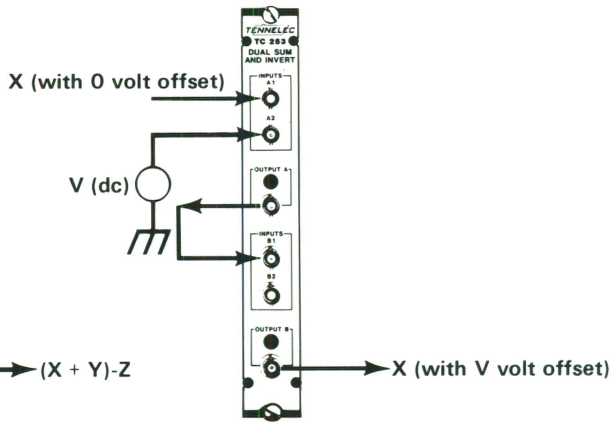
Summing Non-Inverting Amplifier



Subtracting Amplifier



Summing Subtracting Amplifier



Buffer Stage With Level Shift

TENNELEC INC.

TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

PHONE 615-483-8405 TWX 810-572-1018

TC 253 10.0K 286

TENNELEC

TC 256
Alpha Spectrometer

DESCRIPTION

The **TENNELEC** Model **TC 256** is a **complete alpha spectrometer incorporating a vacuum chamber, preamplifier, amplifier, discriminator, biased amplifier, high voltage power supply, and test pulser in a double-width NIM module.** The **low background vacuum chamber, sample holder, and sample tray** enable the **TC 256** to yield counting sensitivities that are essentially limited by the silicon surface barrier detector. The vacuum chamber and sample holder are fabricated of nickel-plated brass and the sample tray is made of stainless steel for low background and ease of decontamination.

Six front-panel selectable energy ranges provide expanded linear regions of 3 to 8, 4 to 7, 3 to 5, 4 to 6, 5 to 7, and 6 to 8 MeV. The **calibrated test pulser** spans the entire range from 0-10 MeV and is conveniently located on the front panel. An **adjustable bias supply** allows most silicon surface barrier detectors to be operated at their optimum bias voltage in the **TC 256**. Replacement detectors are also easily obtainable.

A **linear amplifier output** provides a 0-10 volt analog output which covers the entire energy range of 0-10 MeV. The COUNTS output generates a **logic output for gross alpha counting** with any standard scaler or counter.

The **horizontal sample orientation** minimizes the possibility of detector and vacuum chamber contamination. It also allows optimization of efficiency and resolution with adjustable, reproducible sample spacings of from 1 to 53 mm.

- **Complete alpha spectrometer incorporating a vacuum chamber, preamplifier, amplifier, discriminator, biased amplifier, high voltage power supply, and test pulser in a double-width NIM module**
- **Low background vacuum chamber, sample holder, and sample tray**
- **Six front-panel selectable energy ranges**
- **Calibrated test pulser**
- **Adjustable bias supply**
- **Linear amplifier output and logic output for gross alpha counting**
- **Horizontal sample orientation**

SPECIFICATIONS

PERFORMANCE

SYSTEM BACKGROUND Limited by the silicon surface barrier detector used.

Typical backgrounds:

Detector Active Area	Background
300, 400, 500 mm²	≤20
600 mm²	≤30
1000 mm²	≤60

Backgrounds are total counts above 2.5 MeV for 24 hour counting times.

SAMPLE SIZE Up to 1.75 in. diameter planchets, filter paper, etc.

SAMPLE SPACING Adjustable from 1 to 53 mm from detector in steps of 4 mm.

VACUUM CHAMBER SIZE 1.9 in. wide x 2.25 in. deep x 3.0 in. high (4.83 x 5.72 x 7.62 cm) internal dimensions.

ENERGY RANGES 3-8 MeV, 4-7 MeV, 3-5 MeV, 4-6 MeV, 5-7 MeV, 6-8 MeV.

NONLINEARITY <0.1% of full-scale energy range selected.

DETECTOR VOLTAGE Variable from 0 to ±150V. Polarity selected by internal PCB mounted switch.

OPERATING TEMPERATURE 0 to 50°C

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

OUTPUTS

COUNTS Rear-panel BNC connector provides a NIM-standard positive logic pulse for gross alpha counting or routing. Pulse width 3.5 μs for any event greater than 2.5 MeV. Z_o = 50 ohms; dc-coupled.

ENERGY Rear-panel BNC connector provides a positive pulse (7.75 to 10.25V maximum depending on the setting of the ΔE gain control) corresponding to the energy range selected on the front-panel switch. Z_o = 50 ohms; dc-coupled.

LINEAR AMP Rear-panel BNC connector provides a 0-10V positive unipolar pulse which corresponds to 0-10 MeV. Z_o = 50 ohms; dc-coupled.

BUSY Rear-panel BNC connector provides a NIM-standard positive logic pulse indicating the module is busy processing a pulse. Z_o = 50 ohms; dc-coupled.

TRIGGER Rear-panel BNC connector provides a 1.5V pulse used for oscilloscope triggering. Z_o = 100 ohms; dc-coupled.

DETECTOR MONITOR Rear-panel test points for monitoring detector load current and high voltage.

INPUTS

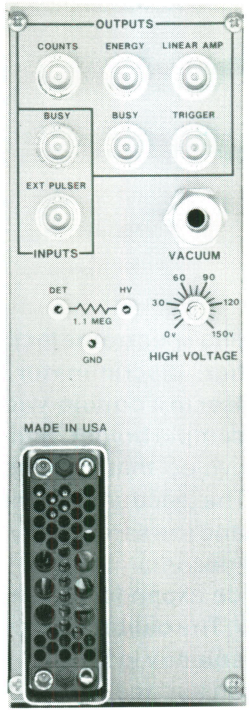
BUSY Rear-panel BNC connector accepts NIM-standard positive logic pulse which is "ORed" with the internal busy to produce a composite BUSY output. Z_{in} = 10k ohms; dc-coupled.

EXT PULSER Rear-panel BNC connector accepts external pulser. Z_{in} = 50 ohms; dc-coupled; sensitivity = 25 MeV/V.

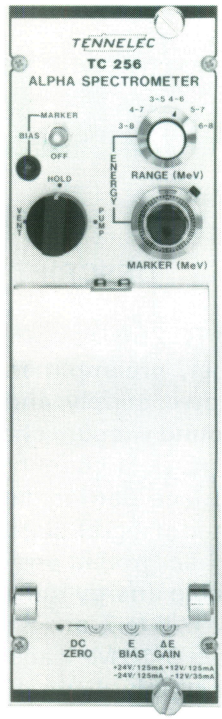
CONTROLS

MARKER/BIAS/OFF Front-panel 3-position locking toggle switch controls both high voltage and pulser. Front-panel BIAS indicator illuminates whenever high voltage is on.

VENT/HOLD/PUMP Front-panel 3-position control for venting or pumping the vacuum chamber. A hold position independently isolates both the vacuum source and chamber.



Rear-panel



Front-panel (Vacuum chamber closed)

ENERGY Six-position front-panel switch for selecting the desired energy range.

MARKER Front-panel 10-turn control for controlling the desired energy of the internal pulser (0 to 10 MeV.)

HIGH VOLTAGE Rear-panel potentiometer for controlling the high voltage applied to the detector. Continuously variable from 0 to $\pm$150V.

VACUUM Rear-panel vacuum pump connector (Swagelok® for 0.25 inch OD) for connecting module to vacuum pump.

DC ZERO Front-panel 25-turn screwdriver-adjustable control allows the dc baseline of the ENERGY output to be adjusted over the range of $\pm$75 mV. A front-panel test point is provided to monitor this voltage.

E BIAS Front-panel 25-turn screwdriver-adjustable control allows the ENERGY output bias point to be varied by $\pm$10% for ease of setup with the MCA.

ΔE GAIN Front-panel 25-turn screwdriver-adjustable control allows the maximum ENERGY output range to be varied from 7.75 to 10.25V for ease of setup with the MCA.

ORDERING INFORMATION

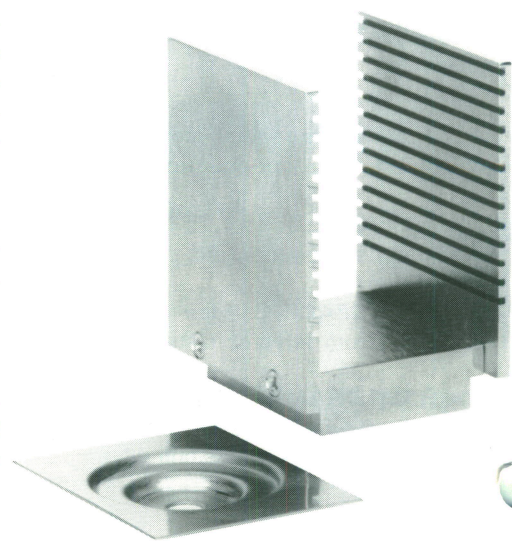
POWER REQUIRED
+24 V, 125 mA; +12 V, 125 mA
-24 V, 125 mA; -12 V, 35 mA

WEIGHT (SHIPPING) 8.5 lbs. (3.86 kg)
(NET) 6.4 lbs. (2.9 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED One sample holder and one sample tray



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 256 10.0K 286

TENNELEC

TC 257
Alpha Spectrometer

DESCRIPTION

The **TENNELEC** Model **TC 257** is a **complete alpha spectrometer** housed in a triple-width NIM module and will accommodate up to **2.25" diameter** samples. The **TC 257** is designed to **complement** the **TENNELEC low-level alpha/beta counting systems** and uses the same **stainless steel** sample carrier inserts for user convenience. It is designed for alpha spectroscopy with **TENNELEC surface barrier detectors** and includes a **vacuum chamber, charges sensitive preamplifier, linear amplifier, discriminator, biased amplifier, variable high voltage bias supply** and **calibrated test pulser.**

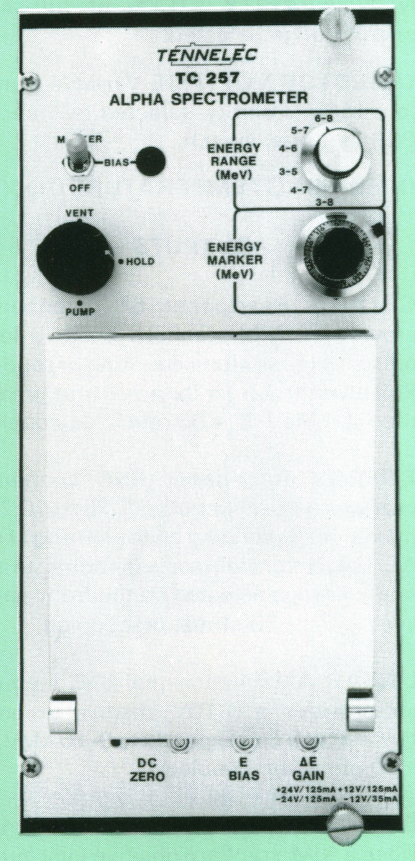
The vacuum chamber and **sample holder** in the **TC 257** are made from **low-background** nickel-plated brass. The sample orientation is horizontal and offers a wide range of **reproducible sample spacings** so that efficiency or resolution may be optimized. The horizontal sample orientation also minimizes detector and vacuum chamber contamination.

A **front-panel switch** allows convenient selection of six specific energy ranges. The **biased amplifier** provides full-scale ranges of 3 to 8, 4 to 7, 3 to 5, 4 to 6, 5 to 7 and 6 to 8 MeV. A **Linear Amp** output provides a 0-10 volt positive pulse which represents the **entire energy span** of 0 to 10 MeV. The **calibrated test pulser** allows the user to scan the complete range of energies from 0-10 MeV.

The **TC 257** is easy to interface with virtually any multichannel analyzer (MCA). Front-panel controls allow the user to adjust the dc baseline ±75 mV (**DC Zero**), the bias amplifier minimum energy range by ±10% (**E Bias**), and the full-scale energy output voltage range from 7.75 to 10.25 volts (**ΔE GAIN**).

With an MCA, vacuum pump and **TENNELEC** silicon surface barrier detector, the **TC 257** provides a **complete, easy to use** alpha spectroscopy system. A four channel system can be easily configured using a **TENNELEC TC 306** Router/Multiplexer.

- **Silicon surface barrier detector alpha spectrometer**
- **Incorporates a vacuum chamber, preamplifier, amplifier, discriminator, biased amplifier, high voltage power supply, and test pulser in a triple-width NIM module**
- **Calibrated output for selected energy ranges**
- **Logic output for gross alpha counting**
- **Horizontal sample orientation**
- **Accommodates up to 2.25" diameter samples**



SPECIFICATIONS

PERFORMANCE

SYSTEM BACKGROUND Limited by the silicon surface barrier detector used. Typical backgrounds:

Detector Active Area	Background
300, 400, 500 mm²	20
600 mm²	30
1000 mm²	60

Backgrounds are total counts above 2.5 MeV for 24 hour counting times.

SYSTEM NOISE Dependent on detector capacitance (See Figure 1) and leakage current.

SAMPLE SIZE Up to 2.25 in. diameter planchets, filter paper, etc.

SAMPLE SPACING Adjustable from 1 to 53 mm from detector in steps of 4 mm.

VACUUM CHAMBER SIZE 2.75 in. wide x 2.50 in. deep x 3.0 in. high internal dimensions.

TENNELEC INC.
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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 257 ALPHA SPECTROMETER

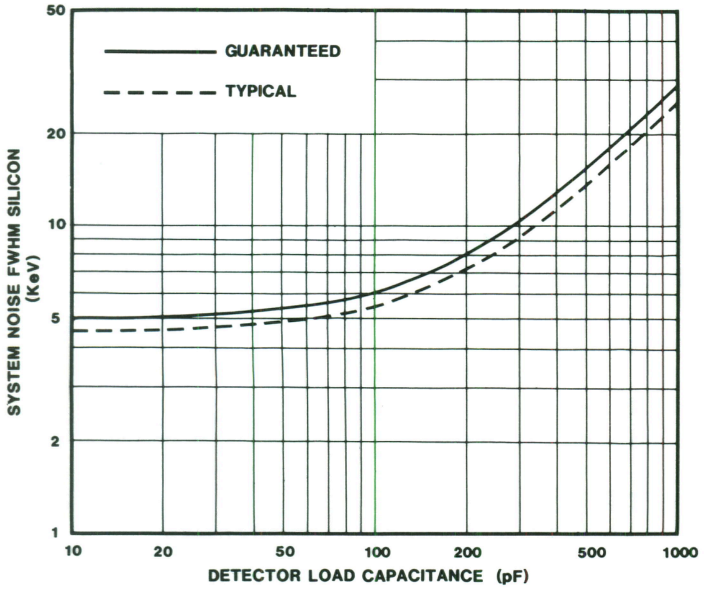


FIGURE 1. TC 257 System Resolution

ENERGY RANGES 3-8, 4-7, 3-5, 4-6, 5-7, 6-8 MeV.

NONLINEARITY <0.1% of full-scale energy range selected.

DETECTOR VOLTAGE Variable from 0 to ±150V. Polarity selected by internal PCB mounted switch.

OPERATING TEMPERATURE 0 to 50°C

OUTPUTS

COUNTS Rear-panel BNC connector provides a NIM-standard positive logic pulse for gross alpha counting or routing. Pulse width 3.5 μs for any event greater than 2.5 MeV. Z_o = 50 ohms; dc-coupled.

ENERGY Rear-panel BNC connector provides a positive pulse (7.75 to 10.25V maximum depending on the setting of the **ΔE GAIN** control) corresponding to the energy range selected on the front-panel switch. Z_o = 50 ohms; dc-coupled.

LINEAR AMP Rear-panel BNC connector provides a 0-10V positive unipolar pulse which corresponds to 0-10 MeV. Z_o = 50 ohms; dc-coupled.

BUSY Rear-panel BNC connector provides a NIM-standard positive logic pulse indicating the module is busy processing a pulse. Z_o = 50 ohms; dc-coupled.

TRIGGER Rear-panel BNC connector provides a 1.5V pulse used for oscilloscope triggering. Z_o = 100 ohms; dc-coupled.

DETECTOR MONITOR Rear-panel test points for monitoring detector leakage current and high voltage.

INPUTS

BUSY Rear-panel BNC connector accepts NIM-standard positive logic pulse for deadtime monitoring. Z_{in} = 10k ohms; dc-coupled.

EXT PULSER Rear-panel BNC connector accepts external pulser. Z_{in} = 50 ohms; dc-coupled.

CONTROLS

MARKER/BIAS/OFF Front-panel 3-position locking toggle switch controls both high voltage and pulser. Front-panel BIAS indicator illuminates whenever high voltage is on.

VENT/HOLD/PUMP Front-panel 3-position control for venting or pumping the vacuum chamber. A hold position independently isolates both the vacuum source and chamber.

ENERGY Six-position front-panel switch for selecting the desired energy range.

MARKER Front-panel 10-turn control for controlling the desired energy of the internal pulser (0 to 10 MeV).

HIGH VOLTAGE Rear-panel potentiometer for controlling the high voltage applied to the detector. Continuously variable from 0 to ±150V.

VACUUM Rear-panel vacuum pump connector (Swagelok® for 0.25 inch OD) for connecting module to vacuum pump.

DC ZERO Front-panel 25-turn screwdriver-adjustable control allows the dc baseline of the ENERGY output to be adjusted over the range of ±75 mV. A front-panel test point is provided to monitor this voltage.

E BIAS Front-panel 25-turn screwdriver-adjustable control allows the ENERGY output bias point to be varied by ±10% for ease of setup with the MCA.

ΔE GAIN Front-panel 25-turn screwdriver-adjustable control allows the maximum ENERGY output range to be varied from 7.75 to 10.25V for ease of setup with the MCA.

ORDERING INFORMATION

POWER REQUIRED
+24 V, 125 mA; +12 V, 125 mA
−24 V, 125 mA; −12 V, 35 mA

WEIGHT (SHIPPING) 10.0 lbs. (4.54 kg)
(NET) 8.0 lbs. (3.64 kg)

DIMENSIONS Standard triple-width NIM module (4.05 x 8.714 in.) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED One sample holder rack, one sample holder, one 1/16 x 2 inch planchet and one 1/8 x 2 inch planchet.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TC 257 10.0K 885

TENNELEC

TC 306
Router/Multiplexer

DESCRIPTION

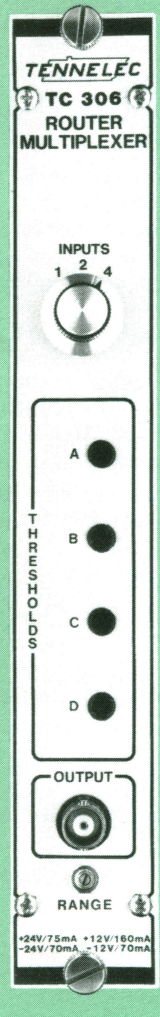
The TENNELEC Model TC 306 is a combination **four input analog multiplexer and router** packaged in a NIM-standard single-width module. The TC 306 was developed specifically to accept from 1 to 4 amplifier outputs to be multiplexed into a single signal which **can be applied to any Multichannel Analyzer** (MCA).

The multiplexer features analog gate circuits which **eliminate multiple input noise summation**. Inputs are processed on a first-come-first-serve basis with multiple input coincident events rejected. The active input is selected by an input detection circuit with **independently adjustable thresholds**.

The function of a router is to compress the multiplexed signal and provide an offset which will steer the resultant signal into the appropriate memory segment of an MCA. Digital routers generate binary signals representing an offset which must be logically added to the digitally compressed output of an Analog-to-Digital Converter (ADC). These devices require custom interfaces to insure the adherence to the signal timing and bus protocals of specific MCA's. The TC 306 router circuit employs state-of-the-art design techniques to linearly compress the input signal and add the appropriate analog offset prior to the ADC, thus the **TC 306 avoids the complex interfacing associated with digital routers**.

The excellent linearity and input isolation preserves the pulse height integrity of the input signals. The TC 306 processes and reshapes each input signal into a **1.5 microsecond wide output pulse** universally accepted by all MCA's.

- **Multiplex and route up to 4 inputs**
- **Independently adjustable thresholds**
- **No multiple input noise summation**
- **Analog routing technique eliminates complex I/F**
- **Universally accepted output**



SPECIFICATIONS

PERFORMANCE

CAPACITY 1 to 4 positive unipolar or positive lobe leading bipolar inputs.

NONLINEARITY ≤0.05% over upper 98% of input range with a 1 μsec shaped pulse and minimum threshold.

INPUT ISOLATION 80 db typical cross-talk between inputs.

STABILITY
Gain ≤0.01%/°C 0-50°C
Threshold ≤0.01%/°C 0-50°C
Offset ≤50 μV/°C 0-50°C

SPECTRUM BROADENING* Typically contributes less than 1.5% to the FWHM broadening exhibited by the main shaping amplifier for a ^{60}Co 1.33-MeV gamma line at 85% of full scale for incoming count rates to 50k cps.

SPECTRUM SHIFT* Typically contributes less than ±.01% to the peak position shift exhibited by the main shaping amplifier for a ^{60}Co 1.33-MeV gamma line at 85% of full scale for incoming count rates to 50k cps.

*Measurements were made with a TC 205A amplifier operating with a 3 μsec shaping time and a TC 306 operating in the single input mode.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 306 Router/Multiplexer

CONTROLS

INPUTS 1-2-4 Input selection switch determines the number of active inputs being multiplexed. This switch affects the gain and offset of the active inputs according to the following chart:

Inputs Selection	Active Input	Gain	Output Offset
1	A	1	0.0 V
2	A	1/2	0.0 V
	C	1/2	5.0 V
4	A	1/4	0.0 V
	B	1/4	2.5 V
	C	1/4	5.0 V
	D	1/4	7.5 V

THRESHOLDS A-D Front-panel 10-turn potentiometers set the discriminator level for the respective input from 35 to 265 mV.

RANGE Front-panel 10-turn potentiometer adjusts the maximum output range from 7.75 to 10.25 volts.

CONNECTORS

OUTPUT Front-and rear-panel BNC connectors furnish 0-10 volt (dependent upon range adjustment) positive unipolar pulses characteristic in pulse height to the multiplexed input. Output pulses are delayed from the input peak by 0.5 microseconds and are 1.5 microseconds wide with 0.5 microseconds risetimes and falltimes; Z_{out} = 50 ohms dc coupled.

INPUT A-D Rear-panel BNC connectors provide direct coupled inputs for positive unipolar or positive lobe leading bipolar pulses from 0 to 10 volts with 0.5 to 10 microsecond shaping or rectangular pulses with a minimum risetimes of 0.5 microseconds; Z_{in} = 1000 ohms.

ORDERING INFORMATION

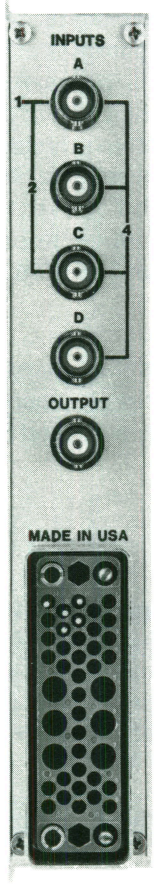
POWER REQUIREMENTS
+24 V, 60 mA; +12 V, 150 mA
−24 V, 75 mA; −12 V, 65 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.0 lbs. (0.9 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714) per TID-20893 (Rev.).

WARRANTY One Year.

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
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TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 306 10.0K 882

TENNELEC

TC 307
Linear Gate

DESCRIPTION

The TENNELEC TC 307 Linear Gate is a single-width NIM module designed to transmit or block **positive or negative linear input signals** according to the presence or absence of a gate signal.

The TC 307 is **dc-coupled** which permits operation at high counting rates without baseline shift. In addition, the linear input may have any shape or polarity; i.e. sinewave, dc, or pulses.

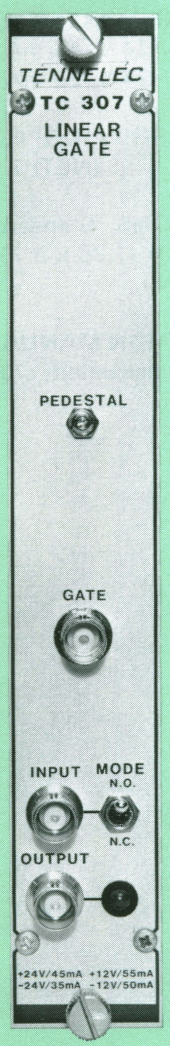
The TC 307 has two modes of operation: **normally open or normally closed**. In the normally open mode, input signals will pass through the linear gate unless blocked by an external gate pulse. In the normally closed mode, input signals will be blocked unless accompanied by an external gate signal. A front-panel pedestal adjustment is provided to eliminate offsets when the gate is opened or closed.

The **superb linearity of the TC 307** makes it ideal for any linear signal gating system.

An **LED count indicator** provides a visual indication that the instrument is producing output pulses.

All connectors are duplicated on both the front and rear panels.

- **Accepts positive or negative linear inputs**
- **dc-coupled for high count rate capability**
- **Normally open or normally closed operation**
- **Nonlinearity <0.05%**
- **LED count indicator**



SPECIFICATIONS

PERFORMANCE

GAIN Unity

NONLINEARITY <0.05%, 0 to ± 10 volts

PULSE FEEDTHROUGH < 5 mV with a 10 V input pulse

TEMPERATURE INSTABILITY
Gain ⩽ ± 0.01%/°C, 0 to 50°C

Zero ⩽ ± 100 μV/°C, 0 to 50°C

LINEAR RISETIME
< 40 nsec, 0 to ± 10 V

OPERATING TEMPERATURE
0 to 50°C

CONTROLS

MODE Front-panel, two-position toggle switch permits selection of normally-open or normally-closed operation.

PEDESTAL Front-panel 25-turn potentiometer allows adjustment such that no pedestal is produced when the gate is opened or closed. Adjustable from −250 mV to +250 mV.

INPUTS

LINEAR INPUT Front- and rear-panel BNC connectors accept positive or negative signals; 0 to ± 10 V, 45 V max; Z_{in} = 2k ohms; dc coupled.

TENNELEC INC.
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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 307 Linear Gate

GATE INPUT Front- and rear-panel BNC connectors accept any positive input > 1 V, maximum input 20 V. Internal gating width equal to gate input width, dc-coupled, Z_{in} = 1k ohms.

OUTPUTS

OUTPUT Front- and rear-panel BNC connectors provide gated signal; output ±10V, 12 V max; dc-coupled. Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel connectors.

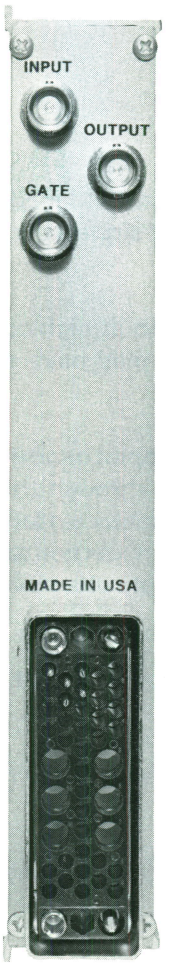
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 45 mA; +12 V, 55 mA
-24 V, 35 mA; -12 V, 50 mA

WEIGHT (SHIPPING) 4.0 lbs. (1.82 kg)
(NET) 2 lbs. (0.91 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.



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TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
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TC 307 10.0K 885

TENNELEC

TC 308
Dual Linear Gat

DESCRIPTION

The **TENNELEC TC 308** contains **two linear gates in a single-width NIM module** designed to transmit or block **positive or negative linear input signals** according to the presence or absence of a gate signal.

Each linear gate is **dc-coupled** which permits operation at high counting rates without baseline shift. In addition, the linear input may have any shape or polarity; i.e. sinewave, dc, or pulses.

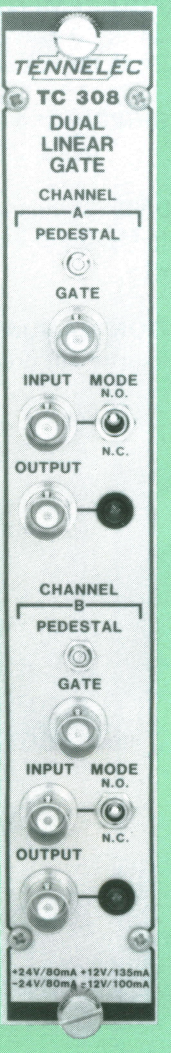
The **TC 308** has two modes of operation: **normally open or normally closed.** In the normally open mode, input signals will pass through the linear gate unless blocked by an external gate pulse. In the normally closed mode, input signals will be blocked unless accompanied by an external gate signal. A front-panel pedestal adjustment is provided to eliminate offsets when the gate is opened or closed.

The **superb linearity of the TC 308** makes it ideal for any linear signal gating system.

An **LED count indicator** provides a visual indication that each channel is producing output pulses.

All connectors are duplicated on both the front and rear panels.

- **Two linear gates in one single-width NIM module**
- **Accepts positive or negative linear inputs**
- **dc-coupled for high count rate capability**
- **Normally open or normally closed operation**
- **Nonlinearity <0.05%**
- **LED count indicator**



SPECIFICATIONS

The following PERFORMANCE, CONTROLS, and CONNECTOR specifications apply to each linear gate channel.

PERFORMANCE

GAIN Unity

NONLINEARITY <0.05%, 0 to ±10 volts

PULSE FEEDTHROUGH <5 mV with a 10 V input pulse

TEMPERATURE INSTABILITY
Gain ≤±0.01%/°C, 0 to 50°C

DC ≤± 100 μV/°C, 0 to 50°C

LINEAR RISETIME
<40 nsec, 0 to ± 10 V

OPERATING TEMPERATURE
0 to 50°C

CONTROLS
(Identical for both sections)

MODE Front-panel, two-position toggle switch permits selection of normally-open or normally-closed operation.

PEDESTAL Front-panel 25-turn potentiometer allows adjustment such that no pedestal is produced when the gate is opened or closed. Adjustable from −250 mV to +250 mV.

INPUTS
(Identical for both sections)

LINEAR INPUT Front- and rear-panel BNC connectors accept positive or negative signals; 0 to ± 10 V, 45 V max; Rise-time ≤ 40 nsec; Z_{in} = 2k ohms; dc coupled.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 308 Dual Linear Gate

GATE INPUT Front- and rear-panel BNC connectors accept any positive input > 1 V, maximum input 20 V. Internal gating width equal to gate input width, dc-coupled, Z_{in} = 1k ohm.

OUTPUTS
(Identical for both sections)

OUTPUT Front- and rear-panel BNC connectors provide gated signal; output ±10 V, 12 V max; dc-coupled. Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel connectors.

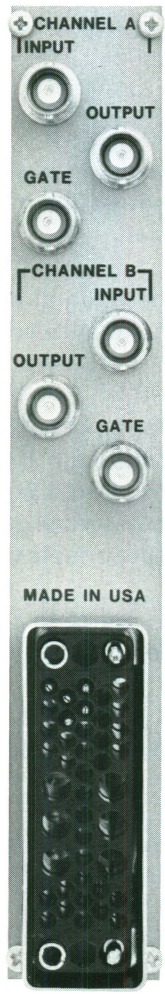
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 135 mA
-24 V, 80 mA; -12 V, 100 mA

WEIGHT (SHIPPING) 4.0 lbs. (1.82 kg)
(NET) 2 lbs. (0.91 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
TC 308 10.0K 286

TENNELEC

TC 404A
Multipurpose Coincidence

DESCRIPTION

TENNELEC's TC 404A Multipurpose Coincidence is a general purpose, high performance coincidence unit that features **five dc-coupled inputs**.

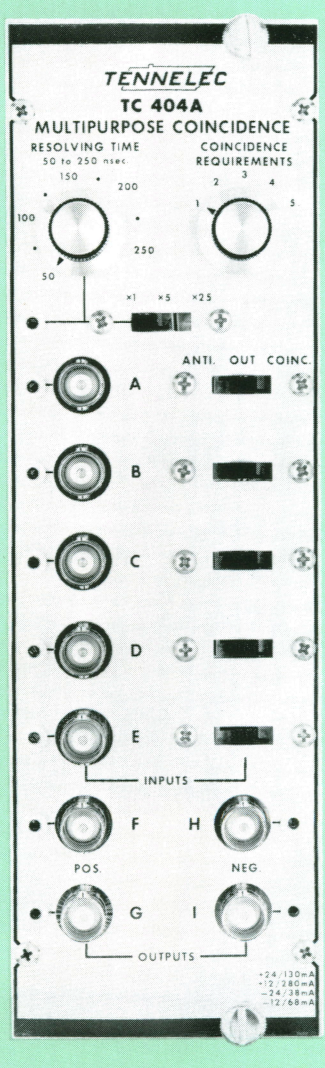
The **resolving time** of the module may be **varied** over a 50 nsec to 6.25 μsec range via a single-turn control and range multiplier, providing accurate resettability.

Three-position sliding switches associated with each channel provide **three operating modes:** coincidence, anticoincidence and out (disabled).

A **coincidence requirements** control is available for **selection** of the number of coincidence inputs required to produce an output. One, two, three, four, or five coincident pulses can be selected for production of an output pulse.

A unique feature of the TC 404A concerns the concept of **controlled inputs.** The resolving time inspection period is initiated only after a pulse is applied to a controlled input. Input A of the TC 404A is always a controlled input. Inputs B through E can each be either controlled or non-controlled inputs by the addition or removal of PCB mounted jumpers. This feature greatly increases the flexibility of the TC 404A and reduces the detection of false or erroneous coincidence events.

- **Dc-coupled**
- **Adjustable resolving time**
- **Coincidence or anticoincidence mode**
- **Controlled inputs**
- **Selectable coincidence requirements**



SPECIFICATIONS

PERFORMANCE

RESOLVING TIME Variable from 50 nsec to 6.25 μsec.

TEMPERATURE INSTABILITY <0.2%/°C, 0 to 50°C.

CONTROLS

RESOLVING TIME Front-panel potentiometer for controlling resolving time for inputs; covers range from 50 nsec to 250 nsec. A slide switch is also provided as a multiplier with positions X1, X5, and X25, extending the total range from 50 nsec to 6.25 μsec.

COINCIDENCE REQUIREMENTS Front-panel switch selects the number of coincidence inputs (1, 2, 3, 4, or 5) necessary to produce an output.

INPUT CONTROLS Front-panel 3-position slide switches select coincidence, anticoincidence or out (disabled) mode for each of the five inputs.

INPUTS

INPUTS Front-panel BNC connectors provide 5 inputs (A, B, C, D, and E) of positive polarity; 1.0 volt threshold, 50 nsec minimum width required; absolute maximum input 30 volts; Z_{in} = 1K Ω, dc-coupled.

OUTPUTS

OUTPUTS 4 buffered outputs are provided via front-panel BNC connectors; 2 NIM-standard slow positive logic signals and 2 NIM-standard fast negative logic signals, Z_o = 50Ω.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 404A
Multipurpose Coincidence

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 130 mA; +12 V, 280 mA
−24 V, 38 mA; −12 V, 68 mA

WEIGHT (SHIPPING) 5.5 lbs. (2.5 kg)
(NET) 3.0 lbs. (1.3 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 404A 10.0K 1085

TENNELEC

TC 410A
Delay and Gate Generator

DESCRIPTION

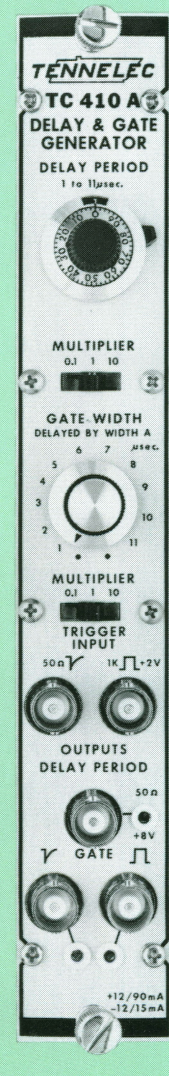
The TENNELEC TC 410A Delay and Gate Generator accepts either positive or negative logic pulses and provides a **delay of up to 110 μsec.** The output from the TC 410A can be either positive or negative polarity with a selected pulse width from 100 nsec to 110 μsec.

In addition to providing both positive and negative delayed pulses, a Delayed Period output is available whose width is equal to the delay period set by the front-panel 10-turn potentiometer.

Excellent time stability allows application where high time precision is needed.

An instrument producing **either positive or negative standard logic signals** may be used as an input to the TC 410A. Because of the module's versatility, the output can be set for compatibility with essentially all commercially available nuclear instrumentation.

- **Provides delay times from 100 nsec to 110 μsec**
- **Excellent time delay stability**
- **Accepts either positive or negative logic signals**
- **Excellent linearity**



SPECIFICATIONS

PERFORMANCE

DELAY NONLINEARITY ±2%.

DELAY TEMPERATURE INSTABILITY ≤±0.08%/°C.

DELAY DEAD TIME 100 nsec plus pulse width.

DELAY JITTER <0.02%.

CONTROLS

DELAY PERIOD Front-panel 10-turn potentiometer with direct reading dial for continuous adjustment within the range selected by the 3-position multiplier slide switch (0.1, 1, 10).

GATE WIDTH Front-panel single-turn potentiometer works in conjunction with 3-position multiplier slide switch to provide output pulses adjustable from 100 nsec to 110 μsec.

INPUTS

POSITIVE Front-panel BNC connector +2.0 V minimum, 20 nsec minimum width, dc-coupled; Z_{in} = 10 KΩ.

NEGATIVE Front-panel BNC connector 14 mA @ 50 Ω, 10 nsec minimum width, dc-coupled; Z_{in} = 50Ω.

OUTPUTS

DELAY PERIOD Front-panel BNC connector provides a positive pulse whose width is equal to the adjusted delay period. Amplitude +5 V, Z_o = 50 Ω.

POSITIVE Front-panel BNC connector provides output pulse; amplitude +5 V, Z_o = 50 Ω.

NEGATIVE Front-panel BNC connector provides negative logic out; amplitude 14 mA @ 50 Ω, Z_o = 50Ω.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 90 mA
−24 V, 0 mA; −12 V, 15 mA

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 410A
Delay and Gate Generator

WEIGHT (SHIPPING) 4.8 lbs. (2.2 kg)
(NET) 2.8 lbs. (1.3 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 410A 10.0K 985

TENNELEC

TC 412A
Nanosecond Delay

DESCRIPTION

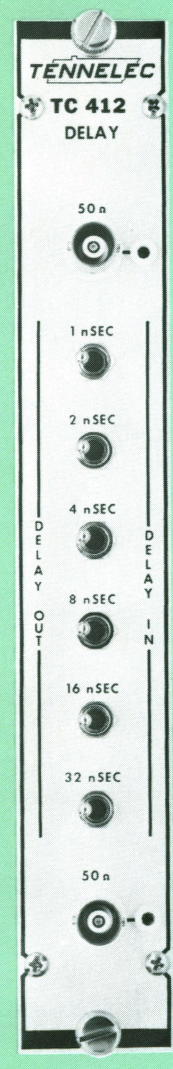
The **TENNELEC TC 412A** Nanosecond Delay is a single-width NIM module which permits the delay of linear and logic signals in **1 nsec steps from 0 to 63 nsec.**

Longer delays are accomplished by cascading additional units. Since the delays are accomplished by means of coaxial cables, **no power is required** for operation of the module, and **high accuracy** is assured.

Six front-panel toggle switches allow the selection of 1, 2, 4, 8, 16 or 32 nanoseconds of delay time.

The **TC 412A** is useful in the alignment of fast timing channels which operate coincidence circuits or time-to-pulse-height converters.

- **No power required**
- **Delays up to 63 nsec in 1 nsec steps**
- **High accuracy**



SPECIFICATIONS

PERFORMANCE

DELAY INACCURACY ±100 psec or 1% whichever is greater, for each delay section used.

MINIMUM DELAY 3.1 nsec with all switches in the OUT position.

DELAY RANGE Switch selectable from 1.0 to 63.0 nsec in 1.0 nsec increments.

INTERNAL RESISTANCE 0.027 ohms per nsec + 0.03 ohms.

CONTROLS

DELAY Six front-panel toggle switches select delays of 1, 2, 4, 8, 16 or 32 nanoseconds.

INPUTS

INPUT Front-panel BNC connector accepts positive or negative NIM logic or linear pulses ±600 volts maximum; Z_{in} = 50 ohms, connector grounded to front panel.

OUTPUT

OUTPUT Front-panel BNC connector furnishes output signals with the delay selected by the switches; Z_{out} = 50 ohms, connector grounded to front panel.

ORDERING INFORMATION

POWER REQUIREMENTS
None required

WEIGHT (SHIPPING) 4 lbs. (1.81 kg)
(NET) 1.8 lb. (0.82 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.

TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 412A 10.0K 686

TENNELEC

TC 450
Single Channel Analyzer

DESCRIPTION

The TENNELEC Model TC 450 Single Channel Analyzer has the **exceptionally wide dynamic range,** high stability, and resolution that are necessary for use in high-resolution counting applications. It is compatible with the stringent requirements of germanium detectors, and is more than adequate for scintillation counters, ionization chambers, etc. The unit is contained in a **NIM-standard single width module** and employs integrated circuit logic to assure superior reliability in the minimum space.

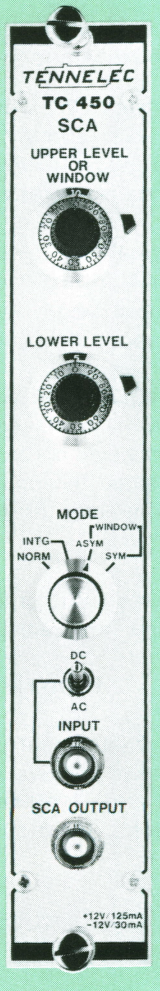
The TC 450 accepts either **positive unipolar or bipolar input pulses** from linear amplifiers that have **either RC or delay-line shaping.** It examines the amplitude of each input pulse and generates appropriate NIM-standard positive logic output pulses separately for SCA, LLD, and ULD responses.

The TC 450 has **four basic modes of operation.** In the **integral (INTG) mode,** an output signal is generated if the input pulse amplitude exceeds the lower level threshold. In the **normal (NORM) mode,** the TC 450 provides an output pulse if the input pulse amplitude exceeds the lower level but does not exceed the upper level setting. In this mode, both lower level and upper level thresholds are adjustable from 20mV to 10V. In the **asymmetrical (ASYM) window mode,** the TC 450 operates as a high-resolution, narrow (0 to 10%) window single channel analyzer. In the **symmetrical (SYM) window mode,** the window adjustment increases symmetrically above and below the lower level threshold, allowing the operator to set the window quickly and easily at the full width half maximum (FWHM), full width tenth maximum (FWTM) positions, etc.

For applications where it is desirable to investigate an entire spectrum, an external baseline sweep input is provided by way of the rear panel lower level reference (LL REF) allowing remote scanning through the spectral range.

Through the use of a separate lower level (LL) output and upper level (UL) output, the unit can operate as a dual wide-dynamic range integral discriminator for pulse routing.

- **Exceptionally wide dynamic range**
- **NIM-standard single width module**
- **Accepts positive unipolar or bipolar pulses either RC or delay-line shaped**
- **Four modes of operation:**
  - **Integral**
  - **Normal**
  - **Asymmetrical window**
  - **Symmetrical window**



SPECIFICATIONS

PERFORMANCE

DYNAMIC RANGE 500:1.

PULSE-PAIR RESOLVING TIME 100 nsec plus output pulse width.

THRESHOLD TEMPERATURE INSTABILITY ≤0.01%/°C of full scale, 0 to 50°C.

WINDOW WIDTH INCONSTANCY <0.1% variation of full scale window width over the linear 0 to +10V range.

DISCRIMINATOR NONLINEARITY <±0.25% of full scale (integral) for both discriminators.

CONTROLS AND INDICATORS

UPPER LEVEL or WINDOW Front-panel 10-turn potentiometer determines the window width (0 to +1V) in the Win-

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 450
Single Channel Analyzer

dow mode or the upper level (0 to +10V) threshold in the Normal or Integral modes.

LOWER LEVEL Front-panel 10-turn potentiometer adjustable from 0 to +10V; when the rear-panel LL Ref switch selects INT, determines the threshold setting for the lower level discriminator; when the LL Ref switch selects EXT, this control is ineffective.

NORM/INTG/WINDOW ASYM/WINDOW SYM Front-panel 4-position rotary switch selects one of four operating modes:

Normal LL and UL are independently adjustable (20mV to +10V); differential mode is operative.

Integral LL is adjustable from 20mV to +10V, the UL is not operative.

Asymmetrical Window LL sets the baseline level (20mV to +10V) and UL sets the window width (0 to 1V); differential mode is operative.

Symmetrical LL sets the baseline level (20mV to +10V) and the UL sets the window width which is symmetrical about the LL (0 to ±0.5V).

LL REF MODE Rear-panel 2-position toggle switch selects either the front-panel Lower Level control or the voltage signal furnished through the rear-panel LL Ref connector as the lower level threshold.

DC/AC Selects AC or DC coupling to both the front- and rear-panel inputs.

INPUTS

INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar signal, 0 to +10V linear range; ≥100 nsec width; ≥1000 ohm input impedance.

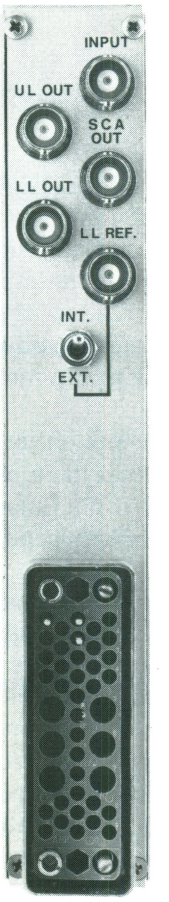
LL REF EXT Rear-panel BNC connector accepts bias for the lower level discriminator when the LL Ref toggle switch selects EXT; 0 to +10V on this connector corresponds to a range of 0 to +10V for the lower level discriminator setting.

OUTPUTS

UL OUT Rear-panel BNC connector provides positive NIM-standard outputs, nominally +5V; 500 nsec wide; Z_o = 50 ohm. Output occurs when the leading edge of the linear input crosses the upper level or window threshold.

SCA OUT Front- and rear-panel BNC connectors provide positive NIM-standard output, nominally +5V; 500 nsec wide; Z_o = 50 ohm. Output occurs when operating mode conditions are met and the trailing edge of the linear input crosses the lower level threshold.

LL OUT Rear-panel BNC connector provides positive NIM-standard output nominally +5V; 500 nsec wide; Z_o = 50 ohm. Output occurs as leading edge of the linear input crosses the lower level threshold.



ORDERING INFORMATION

POWER REQUIREMENTS
+24V, 0mA; +12V, 125mA
−24V, 0mA; −12V, 30mA

WEIGHT (SHIPPING) 5 lbs. (2.27 kg)
(NET) 2 lbs. (0.91 kg)

DIMENSIONS NIM-standard single width module (1.35 × 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
TC 450 10.0K 985

TENNELEC

TC 452
Quad Single Channel Analyzer

DESCRIPTION

The **TENNELEC** Model **TC 452** Quad Single Channel Analyzer offers the performance specifications and ease of use of four independent single channel analyzers in a single-width NIM module. The **TC 452** has an **exceptionally wide dynamic range** of from 20 mV to 10 volts. A **superior pulse pair resolving time** means a higher count rate capability and could also shorten counting times.

The **TC 452** offers **four independent modes of operation: Integral, Normal, Asymmetrical Window,** and **Symmetrical Window** for each of the four channels. In the INTEGRAL mode all input pulses exceeding the lower level discriminator (LLD) setting generate an SCA Output. The NORMAL mode generates an SCA Output if the input pulse exceeds the LLD but is less than the upper level discriminator (ULD) setting. Both window modes produce an SCA Output if the input signal exceeds the LLD but is less than the ULD. In the ASYMMETRICAL mode, the ULD control sets a window width of from .002V to 0.999V and this window follows the LLD setting. In the **exclusive** SYMMETRICAL mode, the LLD establishes the channel center and the ULD control opens a window of from 0.002V to 0.999V symmetrically around it.

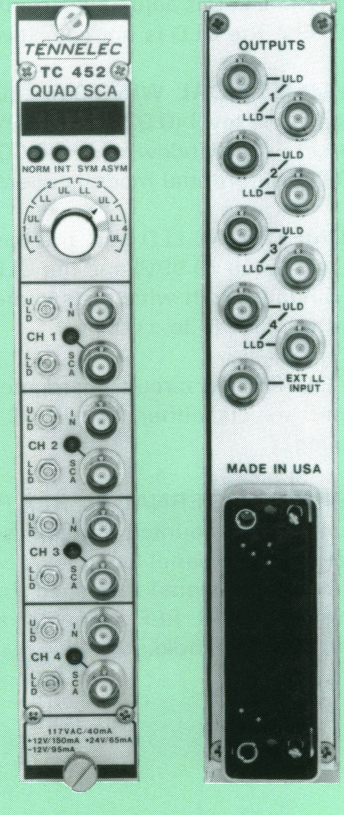
Front-panel **LED channel mode indicators** display the status of each of the four single channel analyzer sections, as selected by an eight-position rotary switch. In addition, **individual LED channel activity indicators** give positive visual feedback that each channel is processing pulses.

The **TC 452** requires only 12, 24, and 117 V power input as supplied by a **standard NIM bin and power supply,** such as the **TENNELEC** model **TB3/TC911.** An **Autoranging digital voltmeter display** provides 1 mV resolution and autoranges to correctly indicate window widths when in the Asymmetrical or Symmetrical modes.

The **TC 452** may be computer controlled as it offers either **internal or external lower level reference for each channel.** The external LLD input may be positive or negative 0 to 10 volts; the **TC 452** provides automatic polarity switching.

DC or AC input coupling for each channel may be selected by an internal jumper.

- **Exceptionally wide dynamic range**
- **Superior pulse-pair resolving time**
- **Four independent modes of operation:**
  - **Integral**
  - **Normal**
  - **Asymmetrical window**
  - **Symmetrical window**
- **LED channel mode indicators**
- **Individual LED channel activity indicators**
- **Autoranging digital voltmeter display**
- **Requires only standard NIM bin and power supply**
- **Internal or external lower level reference for each channel**
- **DC or AC coupled input**



Front Rear

SPECIFICATIONS

The following PERFORMANCE specifications apply to each channel.

PERFORMANCE

DYNAMIC RANGE 500:1.

PULSE PAIR RESOLVING TIME 100 nsec plus output pulse width.

THRESHOLD TEMPERATURE INSTABILITY ≤±0.01%/°C of full scale, 0 to 50°C.

WINDOW WIDTH VARIATION ≤0.1% of full scale window width over the linear 0 to +10V range.

DISCRIMINATOR NONLINEARITY ≤0.1% of full scale for both discriminators.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 452 Quad Single Channel Analyzer

CONTROLS

DVM SWITCH 8-position rotary switch selects the LLD or ULD discriminator threshold for the DVM display.

ULD Front-panel screwdriver adjustable potentiometer to set the upper level discriminator from .02V to 9.99V or window width from 0.002V to 0.999V.

LLD Front-panel screwdriver adjustable potentiometer to set the lower level discriminator from 0.02V to 9.99V.

NORM/INT/SYM/ASYM Internal printed circuit board mounted four-position slide switch selects the operating mode for each channel. Accessible through the module's side shield; mode for each channel is indicated by front-panel LED.

NORMAL LLD and ULD are independently adjustable (0.02V to +9.99V); differential mode is operative.

INTEGRAL LLD is adjustable from 0.02V to +9.99V; the ULD is not operative.

ASYMMETRICAL WINDOW LLD sets the baseline level (0.02V to +9.99V) and ULD sets the window width (0.002V to 0.999V); differential mode is operative.

SYMMETRICAL LLD sets the baseline level (0.02V to +9.99V) and the ULD sets the window width which is symmetrical about the LLD (0 to ±0.5V).

AC/DC Printed circuit board mounted jumper selects either DC or AC input coupling.

INTERNAL/EXTERNAL LL REF Printed circuit board mounted jumper selects either the front-panel lower level control or the voltage signal furnished through the rear-panel LL REF connector as the lower level threshold.

INDICATORS

DIGITAL VOLTMETER Indicates setting of selected threshold. Autoranging in window modes from 0.002V-0.999V. Normal range 0.02V-9.99V.

NORM/INT/SYM/ASYM LED indicators display the selected operation mode for each channel as selected by the front-panel rotary switch.

ACTIVITY LED LED indicators, one per channel, light to show that an SCA output pulse has been generated.

INPUTS

IN Front-panel BNC connectors, one per channel, accept unipolar or bipolar signal, 0 to +9.99V linear range; ≥100 nsec width, Z_{in} ≥900 ohms. Input protected to ±24V.

EXT LL INPUT Rear-panel BNC connector accepts positive or negative 0-9.99V; input displayed on DVM. 0 to ±9.99 volts on this connector corresponds to a 0 to 9.99 volt lower level discriminator setting. Z_{in} ≥10k ohms.

OUTPUTS

SCA Front-panel BNC connectors, one per channel, provide positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs when operating mode conditions are met and the trailing edge of the linear input crosses the lower level threshold.

ULD Rear-panel BNC connectors, one per channel, provide positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs when the leading edge of the linear input crosses the upper level or window threshold.

LLD Rear-panel BNC connector, one per channel, provides positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs as the leading edge of the linear input crosses the lower level threshold.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 65 mA; +12 V, 150 mA
−24 V, 0 mA; −12 V, 95 mA
117 V AC, 40 mA

WEIGHT (SHIPPING) 5.1 lbs. (2.3 kg)
(NET) 2.8 lbs. (1.3 kg)

DIMENSIONS NIM-standard single width module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 452 10.0K 386

TENNELEC

TC 453
100 MHz Constant Fraction Discriminator

DESCRIPTION

The TENNELEC Model TC 453 Constant Fraction Discriminator generates precision timing signals from practically any detector for inputs exhibiting up to a **1000:1 dynamic amplitude range** and up to **100 MHz count rates. Three operating modes** and **selectable fraction modules** insure optimization of the derived timing signal for specific detectors and applications.

The **Constant Fraction** (CF) mode of operation allows the TC 453 to function as either a true CF discriminator or as an Amplitude and Rise time Compensated (ARC) discriminator. The input signal is delayed (via a front-panel delay cable) and activity subtracted from a fraction of the prompt input. The result is a logic signal which occurs when the result of the subtraction crosses zero. The zero crossover occurs at a constant fraction of the input signal rise time. The logic signal produced by the zero crossover is used to produce the discriminator output signals which are inherently free of amplitude induced walk for a wide dynamic range of input signals. The TC 453 exhibits typical **walk of less than ±50 psec for a 100:1 input amplitude range.**

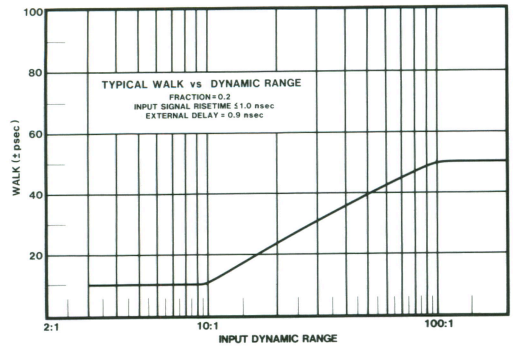
The delay provided via a front-panel coaxial cable is chosen to match the rise time characteristics of the detector signal. The fraction may also be optimized by exchanging Constant Fraction modules within the TC 453. Two of these fraction modules (20% and 40%) are provided with each unit. Other fractions are available by special request.

Certain detectors such as large volume Ge detectors may exhibit a percentage of Slow Rise Time (SRT) signals which result in leading edge type walk. The TC 453 incorporates a **SRT reject mode** which realizes improved timing resolution with these detectors at the expense of counting efficiency.

The TC 453 may be converted into a **100 MHz leading edge discriminator** by replacing the fraction module with the leading edge module. This is the most common operating mode for single photon counting applications.

Two standard **negative NIM outputs** and two **positive outputs** are provided on the TC 453 front panel. The width of the positive output reflects the discriminator dead time. A front panel blocking width adjustment (0 to >500 nsec) establishes the minimum dead time.

A front-panel switch selects either **fixed dead time** (NORM) or **updating dead time** (UPDATE) operation. In the later mode, any pulse arriving during the blocking period of a previous pulse causes the dead time to be extended by an amount equivalent to the blocking width.



- **100 MHz Count Rate Capability**
- **1000:1 Dynamic Range**
- **Typical Walk < ±50 psec for 100:1 Dynamic Range**
- **Three Operating Modes**
  Constant Fraction
  Slow Rise Time Reject
  Leading Edge
- **Selectable Fraction**
- **Fixed or Updating Dead Time Operation**
- **Positive and Negative Outputs**

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 453
100 MHz Constant Fraction Discriminator

SPECIFICATIONS

PERFORMANCE

DYNAMIC RANGE 1000:1

INPUT PULSE CHARACTERISTICS Negative inputs jumper selectable for either −5 mV to −2.5 V or −10 mV to −5.0 V. Input is protected to ±100 V.

PULSE PAIR RESOLVING TIME <8 nsec for input signals with rise time <2 nsec, blocking width at minimum setting.

WALK (Measured with a 1 nsec rise time pulse)

CF mode: < ±100 psec (typically < ±50 psec) for a 100:1 dynamic range.

LE mode: ⩽ ±400 psec typical for a 10:1 dynamic range (x2 to x20 of threshold). ⩽ ±500 psec typical for 100:1 dynamic range (x2 to x200 of threshold).

COUNTING RATE ⩾100 MHz (typically 120 MHz), limited by blocking width setting.

PROPAGATION DELAY Nominally 10 nsec with a 1.5 nsec external delay cable.

PROPAGATION DELAY INSTABILITY ⩽15 psec/°C, 0 to 50°C

LOWER LEVEL THRESHOLD INSTABILITY ⩽0.01%/°C of full scale, 0 to 50°C.

LOWER LEVEL NONLINEARITY < ±0.25% of full scale.

OPERATING TEMPERATURE 0 to 50°C.

CONTROLS

LOWER LEVEL Front-panel 10-turn potentiometer adjustable from 5 mV to 1 V determines the lower level threshold setting.

WALK ADJ Front-panel screwdriver adjustment for precise setting of walk compensation.

SRT/CF Front-panel two-position toggle switch selects either Constant Fraction (CF) or Constant Fraction with Slow Rise Time reject (SRT) operating modes. If the leading edge module is installed, the unit should be operated in CF mode.

BLOCKING WIDTH Front-panel screwdriver adjustment for setting the minimum dead time (0 to >500 nsec) during pulse processing. The blocking width determines the minimum width of the positive output signal.

UPDATE/NORM Front-panel two-position toggle switch selects either fixed dead time (NORM) or updating dead time (UPDATE) operation. In the NORM mode the dead time is determined by the BLOCKING WIDTH adjustment for each pulse processed. Pulses arriving during this period are not processed. In the UPDATE mode pulses which arrive during the blocking width period of a previous pulse extend the dead time by an amount equivalent to the blocking width setting.

INDICATOR

LOWER LEVEL Front-panel LED indicates when a pulse has exceeded the lower level threshold and meets criteria required to produce discriminator outputs.

INPUTS

INPUT Front-panel BNC connector accepts negative signals in the range of −5 mV to −2.5 V or −10 mV to −5.0 V depending upon the position of a PCB mounted jumper. Z_{in} = 50 ohms, dc coupled, protected to ±100 V.

DELAY Two front-panel BNC connectors between which a delay cable (50 ohm impedance) is connected to form the internal constant fraction signal. Recommended lengths are based upon the propagation delay of coaxial cable and the rise time of the discriminator input signal.

OUTPUTS

CFZC MONITOR Front-panel BNC connector provides a constant fraction zero crossing monitor. The width of the pulse is dependent upon input signal level, delay cable and walk adjust setting. Characteristics when terminated by 50 ohms: dc offset = −200 mV, 100 mV positive pulse.

LE MONITOR Front-panel BNC connector provides a monitor pulse with width equal to the input pulse time above lower level threshold. Characteristics when terminated by 50 ohms: dc offset = −200 mV, 100 mV positive pulse.

NEG OUTPUT Two independent front-panel BNC connectors provide fast negative discriminator output signals at the time of constant fraction zero crossing; −16 mA into 50 ohms, ⩽10 nsec wide, Z_o = 50 ohms.

POS OUTPUT Two independent front-panel BNC connectors provide positive outputs nominally +2.2 V terminated, Z_o = 50 ohms. The leading edge occurs at constant fraction zero crossing. The width of the pulse is set by the blocking width adjustment in NORM mode. In UPDATE mode each pulse which arrives during the previous pulse's blocking width will extend the output by an amount equivalent to the blocking width.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 83 mA; +12 V, 130 mA
−24 V, 83 mA; −12 V, 166 mA

WEIGHT (SHIPPING) 4.0 lbs. (1.82 kg)
(NET) 2.1 lbs. (0.96 kg)

DIMENSIONS: Standard single-width NIM module (1.35 x 8.714 in.) per TID 2089 (Rev.).

WARRANTY One Year.

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED Two fraction modules (F = 0.2 and F = 0.4) and one leading edge module provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 453 10.0K 484

TENNELEC

TC 454

200 MHz Quad Constant Fraction Discriminator

DESCRIPTION

The **TENNELEC** Model **TC 454** combines **four 200 MHz Constant Fraction Discriminators** in a single-width NIM module. The proven constant fraction technique generates precision timing signals from fast negative input signals up to a **1000:1 dynamic amplitude range.** Each discriminator exhibits **typical walk of less than ±30 psec for a 100:1 input amplitude range.**

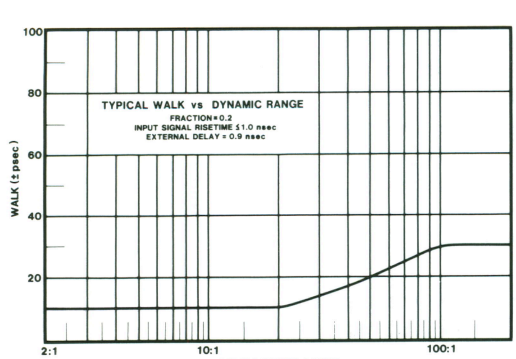
Each of the four independent discriminators has **selectable fraction modules** which can be exchanged for optimum performance with a particular PM tube or solid state detector. The 20% fraction module is supplied for each discriminator section. Other fractions are available as inexpensive options. The discriminators can be converted to a conventional **leading-edge discriminator** by use of the appropriate module available from the factory. The delay required to internally generate the constant fraction timing signal is provided externally by the proper length of cable across the delay connectors.

Each discriminator has a separate threshold adjustment and monitor (T), and walk adjustment and monitor (Z). Another output (Z/C MON) is available to allow monitoring of the internally produced zero-cross signal which coincides with the constant fraction timing mark.

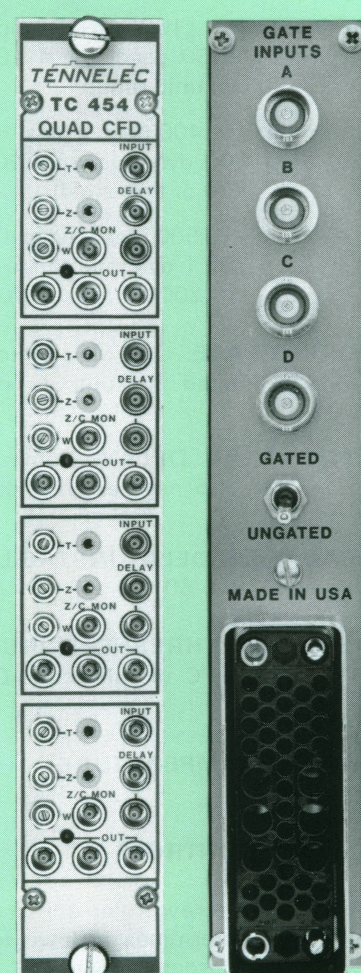
Three independent fast negative outputs are provided for each discriminator. A width adjustment allows the output to vary from less than 4 nsec to greater than 500 nsec in two ranges. This allows compatibility with certain devices such as counters being driven by the **TC 454** and prevents false triggering from trailing edge noise which can be encountered with certain detectors. A visual indication of disciminator activity is provided by an **output LED.**

Rear-panel inputs allow each of the discriminators to be **independently gated** from an external source. Also a master BIN gate signal available on special NIM bins may be used to control the **TC 454.** Internal switches allow any combination of the discriminator sections to be controlled by the BIN gate.

The **TC 454** is compatible with the NIM-standard type V-H bin and power supplies that include ±24V, ±12V and ±6V such as the **TENNELEC TB3/TC911-6.**



- **Four CF Discriminators in a Single-Width NIM**
- **200 MHz Count Rate Capability**
- **1000:1 Dynamic Range**
- **Typical Walk < ±30 psec for 100:1 Dynamic Range**
- **Selectable Fraction or Leading Edge Operation**
- **Output indicator LED**
- **Gated Operation**



Front **Rear**

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 454 200 MHz Quad Constant Fraction Discriminator

SPECIFICATIONS

PERFORMANCE

DYNAMIC RANGE 1000:1

INPUT PULSE CHARACTERISTICS Negative inputs jumper selectable for either -5 mV to -2.5V or -10 mV to -5.0V. Input is protected to ±100V.

PULSE PAIR RESOLVING TIME <4.5 nsec for input signal with rise time <2 nsec, output width at minimum setting.

WALK (Measured with a 1 nsec rise time pulse)

CF mode: < ±100 psec (typically <±30 psec) for a 100:1 dynamic range.

LE mode: ⩽ ±400 psec typical for a 10:1 dynamic range (X2 to X20 of threshold).

⩽ ±500 psec typical for 100:1 dynamic range (X2 to X200 of threshold).

COUNTING RATE ⩾200 MHz (typically 240 MHz), limited by output width setting.

PROPAGATION DELAY Nominally 10 nsec with a 1.5 nsec external delay cable.

PROPAGATION DELAY INSTABILITY ⩽10 psec/°C, 0 to 50°C

LOWER LEVEL THRESHOLD INSTABILITY ⩽0.02%/°C of full scale, 0 to 50°C

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

T Front-panel screwdriver-adjustable potentiometer determines the lower level threshold setting from -5 mV to -1V. The T monitor is X10 the actual threshold setting.

Z Front-panel screwdriver adjustment for precise setting of walk compensation.

W Front-panel screwdriver adjustment for setting the width of the output signal. The range of the width adjustment is either <5 nsec to >100 nsec or <10 nsec to >500 nsec depending upon the position of a PCB mounted jumper.

GATED/UNGATED Rear-panel switch enables or disables gated operation. In the GATED position individual discriminator sections may be controlled by the respective rear-panel BNC gate input. Selected discriminator sections will respond to a master BIN gate signal as provided on specially wired NIM bins. An internally mounted PCB switch allows any combination of the four discriminator sections to be tied to the BIN gate.

INDICATORS

OUT Front-panel LED indicates when a pulse has exceeded the lower level threshold and meets criteria required to produce discriminator outputs for each channel.

INPUTS

INPUT Front-panel LEMO connector accepts negative signals in the range of -5 mV to -2.5V or -10 mV to -5.0V depending upon the position of a PCB mounted jumper. Z_{in} = 50 ohms, dc coupled, protected to ±100V.

DELAY Two front-panel LEMO connectors between which a delay cable (50 ohm impedance) is connected to form the internal constant fraction signal. Recommended lengths are based upon the propagation delay of coaxial cable and the rise time of the discriminator input signal.

GATE INPUT Four rear-panel BNC connectors labeled A-D corresponding to the four discriminators provide individual gate control for the respective discriminator. A logic "0" NIM level will disable operation and a logic "1" NIM level or no connection will enable operation.

OUTPUTS

Z/C MON Front-panel LEMO connector provides a constant fraction zero crossing monitor. The width of the pulse is dependent upon input signal level, delay cable and walk adjust setting. Characteristics when terminated by 50 ohms: dc offset = -200 mV, 100 mV positive pulse.

OUT Three independent front-panel LEMO connectors provide fast negative discriminator output signals at the time of constant fraction zero crossing; 16 mA into 50 ohms, width as set by W adjustment, Z_o = 50 ohms.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 35 mA; +6 V, 205 mA
-24 V, 0 mA; -12 V, 160 mA; -6 V, 1.7 A

Note: This module exceeds NIM specification current limits for -6V. Depending upon your power supply, you may not be able to power a fully-loaded bin of these units.

WEIGHT (SHIPPING) 5.0 lbs. (2.28 kg)
(NET) 3.0 lbs. (1.37 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY One 0.2 fraction module per channel included.

OPTIONS 0.1, 0.3, 0.4 and 0.5 fraction modules or leading edge module. Other fraction modules available on special order.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

TC 455
200 MHz Quad Constant Fraction Discriminator

DESCRIPTION

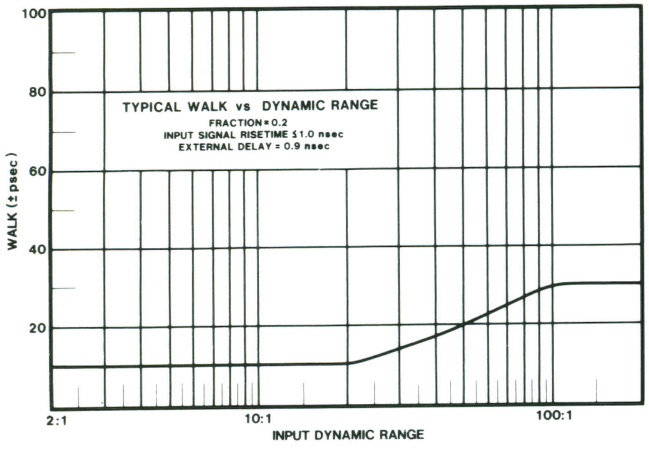
The TENNELEC Model TC 455 combines **four 200 MHz Constant Fraction Discriminators** in a single-width NIM module. The proven constant fraction technique generates precision timing signals from fast negative input signals up to a **1000:1 dynamic amplitude range**. Each discriminator exhibits **typical walk of less than ±30 psec for a 100:1 input amplitude range.**

Each of the four independent discriminators has **selectable fraction modules** which can be exchanged for optimum performance with a particular PM tube or solid state detector. The 20% fraction module is supplied for each discriminator section. Other fractions are available as inexpensive options. The discriminators can be converted to a conventional **leading-edge discriminator** by use of the appropriate module available from the factory. The delay required to internally generate the constant fraction timing signal is provided externally by the proper length of cable across the delay connectors.

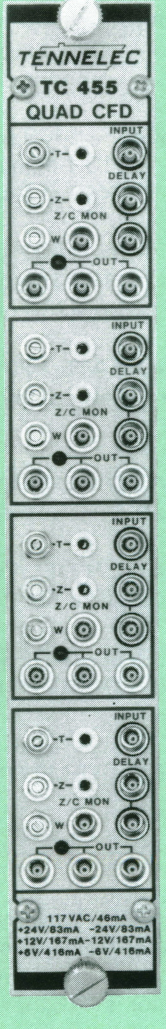
Each discriminator has a separate threshold adjustment and monitor (T), and walk adjustment and monitor (Z). Another output (Z/C MON) is available to allow monitoring of the internally produced zero-cross signal which coincides with the constant fraction timing mark.

Three independent fast negative outputs are provided for each discriminator. A width adjustment allows the output to vary from less than 4 nsec to greater than 500 nsec in two ranges. This allows compatibility with certain devices such as counters being driven by the TC 455 and prevents false triggering from trailing edge noise which can be encountered with certain detectors. A visual indication of discriminator activity is provided by an **output LED**.

The TC 455 is compatible with the NIM-standard type V-H bin and power supplies that include ±24V, ±12V and ±6V such as the TENNELEC TB3/TC 911-6.



- **Four CF Discriminators in a Single-Width NIM**
- **200 MHz Count Rate Capability**
- **1000:1 Dynamic Range**
- **Typical Walk < ±30 psec for 100:1 Dynamic Range**
- **Selectable Fraction or Leading Edge Operation**
- **Output indicator LED**



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 455 200 MHz Quad Constant Fraction Discriminator

SPECIFICATIONS

PERFORMANCE

DYNAMIC RANGE 1000:1

INPUT PULSE CHARACTERISTICS Negative inputs jumper selectable for either -5 mV to -2.5V or -10 mV to -5.0V. Input is protected to ±100V.

PULSE PAIR RESOLVING TIME <5 nsec for input signals with rise time <2 nsec, output width at minimum setting.

WALK (Measured with a 1 nsec rise time pulse)

CF mode: < ±100 psec (typically < ±30 psec) for a 100:1 dynamic range.

LE mode: ⩽ ±400 psec typical for a 10:1 dynamic range (X2 to X20 of threshold).

⩽ ±500 psec typical for 100:1 dynamic range (X2 to X200 of threshold).

COUNTING RATE ⩾200 MHz (typically 240 MHz), limited by output width setting.

PROPAGATION DELAY Nominally 10 nsec with a 1.5 nsec external delay cable.

PROPAGATION DELAY INSTABILITY ⩽10 psec/°C, 0 to 50°C

LOWER LEVEL THRESHOLD INSTABILITY ⩽0.02%/°C of full scale, 0 to 50°C

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

T Front-panel screwdriver-adjustable potentiometer from -5 mV to -1V determines the lower level threshold setting. The T monitor is X10 the actual threshold setting.

Z Front-panel screwdriver adjustment for precise setting of walk compensation.

W Front-panel screwdriver adjustment for setting the blocking width. The output pulse width indicates the output blocking width. The range of the width adjustment is either <5 nsec to >100 nsec or <10 nsec to >500 nsec depending upon the position of a PCB mounted jumper.

INDICATORS

OUT Front-panel LED indicates when a pulse has exceeded the lower level threshold and meets criteria required to produce discriminator outputs.

INPUTS

INPUT Front-panel LEMO connector accepts negative signals in the range of -5 mV to -2.5V or -10 mV to -5.0V depending upon the position of a PCB mounted jumper. Z_{in} = 50 ohms, dc coupled, protected to ±100V.

DELAY Two front-panel LEMO connectors between which a delay cable (50 ohm impedance) is connected to form the internal constant fraction signal. Recommended lengths are based upon the propagation delay of the coaxial cable and the rise time of the discriminator input signal.

OUTPUTS

Z/C MON Front-panel LEMO connector provides a constant fraction zero crossing monitor. The width of the pulse is dependent upon input signal level, delay cable and walk adjust setting. Characteristics when terminated by 50 ohms: dc offset = -200 mV, 100 mV positive pulse.

OUT Three independent front-panel LEMO connectors provide fast negative discriminator output signals at the time of constant fraction zero crossing; -16 mA into 50 ohms, width as set by W adjustment, Z_o = 50 ohms.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 83 mA; +12 V, 167 mA; +6 V, 416 mA
-24 V, 83 mA; -12 V, 167 mA; -6V, 416 mA
117 V AC 46 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.28 kg)
(NET) 3.0 lbs. (1.37 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY One 0.2 fraction module included per channel.

OPTIONS 0.1, 0.3, 0.4 and 0.5 fraction modules or leading edge module. Other fraction modules available on special order.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 455 10.0K 186

TENNELEC

TC 525
1 MHz Ratemeter

DESCRIPTION

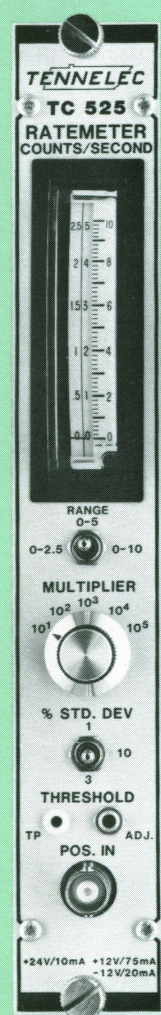
The TENNELEC TC 525 is a **precise, stable 1 MHz linear count ratemeter** packaged in a NIM-standard single-width module. A comprehensive choice of **fifteen full-scale count rate ranges is provided from 25 to 1,000,000 counts per second** with readout provided by an edgewise meter.

A percent standard deviation switch permits operation at a known statistical meter fluctuation with optimum response time.

The TC 525 contains a **built-in integral discriminator** and responds to signals as short as 20 nanoseconds wide. These features allow the TC 525 to accept virtually any positive input pulse.

A **recorder output**, switchable for 100 mV, 1 V, or 10 V full scale, is provided on the rear panel.

- **Precise, stable linear count ratemeter**
- **Fifteen count rate ranges provided from 25 to 1,000,000 counts per second**
- **Built-in integral discriminator**
- **Selectable recorder output**



SPECIFICATIONS

PERFORMANCE

NONLINEARITY ≤0.1% of full scale at recorder output.

TEMPERATURE STABILITY 0.008% per °C from 0 to 50°C.

ACCURACY
METER ≤3% of full scale
RECORDER OUTPUT ≤1% of full scale

PULSE-PAIR RESOLUTION ≤40 nsec

CONTROLS AND DISPLAYS

DISPLAY Edgewise meter on front panel with three linear scales; 0 to 2.5, 0 to 5.0, and 0 to 10. Meter has built-in mechanical zero adjustment.

RANGE Front-panel 3-position toggle switch selects full-scale ranges of 2.5, 5, and 10 counts per second. Operates in conjunction with the MULTIPLIER switch to determine full scale counts per second.

MULTIPLIER Front-panel 8-position rotary switch selects the range multiplier of 10, 10^2, 10^3, 10^4, or 10^5 for total full scale ranges of from 25 to 1,000,000 counts per second.

% STD. DEV. Front-panel 3-position switch selects percent standard deviation of 1, 3, and 10% at full scale.

THRESHOLD Front-panel potentiometer adjusts integral input discriminator from +0.15 V to +10 V. A test point is provided for monitoring the threshold setting.

OUTPUT RANGE An easily removable PC mounted jumper selects 100 mV, 1 V, or 10 V full range.

INPUTS

POS IN Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ±25 V. Input amplitude must exceed the threshold level for 20 nsec. Pulse-pair resolution ≤40 nsec; input impedance 1 k ohms; dc-coupled.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 525
1 MHz Ratemeter

OUTPUT

ANALOG OUTPUT Rear-panel BNC connector for connection to strip chart recorder or other analog recording devices. An easily removed PCB jumper selects full scale output of 100 mV, 1 V, or 10 V; output impedance 50 ohms.

ORDERING INFORMATION

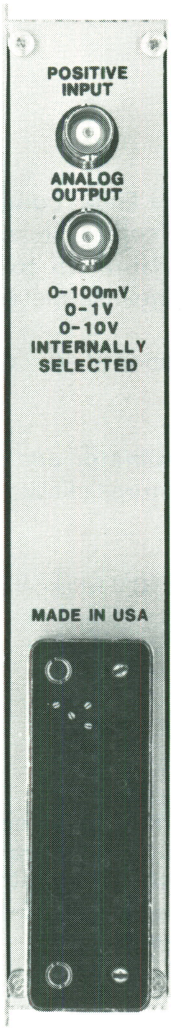
POWER REQUIREMENTS
+24 V, 10 mA; +12 V, 75 mA
−24 V, 0 mA; −12 V, 20 mA

WEIGHT
(SHIPPING) 5 lbs. (2.3 kg)
(NET) 2 lbs. 10 oz. (1.19 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 525 10.0K 584

TENNELEC

TC 526
100 MHz Ratemeter

DESCRIPTION

The TENNELEC TC 526 is a **precise, ultra stable 100 MHz linear count ratemeter** packaged in a NIM-standard single-width module.

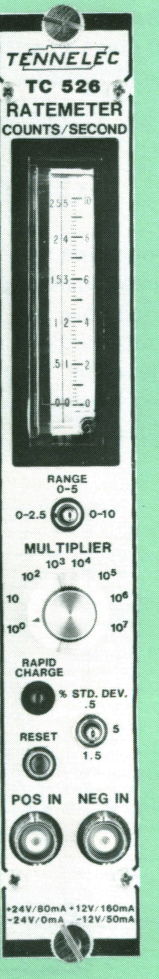
The TC 526 utilizes a **unique crystal controlled digital rate measurement technique** allowing **twenty-four (24) ranges** to be selected via the front-panel control. Full scale ranges from **2.5 to 100,000,000 counts per second** are available. The TC 526 features an edgewise meter for a visual count rate indicator. **A recorder output with selectable full-scale output voltages** (100 mV, 1 V, or 10 V) is included on the rear panel.

A percent standard deviation switch permits operation at a known statistical meter fluctuation with optimum response time.

A **built-in integral discriminator** which responds to signals as short as 20 nanoseconds allows the TC 526 to accept virtually any positive input pulse. The negative input accepts standard negative NIM signals and expands the TC 526 count rate capabilities up to 100,000,000 counts per second.

Under certain conditions (for example with low count rates and 0.5% standard deviation selected) a count rate meter can take a relative long time to reach its steady state level. The TC 526 features a **"RAPID CHARGE" circuit** which when invoked permits the unit to reach this steady state condition up to 400 times faster than conventional ratemeters.

- **Ultra stable, linear ratemeter**
- **Unique digital rate measurement technique**
- **2.5 to 100,000,000 counts per second**
- **Built-in integral discriminator**
- **Selectable recorder output**
- **Exclusive Rapid Charge Feature**



SPECIFICATIONS

PERFORMANCE

NONLINEARITY ≤0.1% of full scale at recorder output

TEMPERATURE STABILITY
≤0.002% per °C from 0 to 50°C

ACCURACY
METER ≤3% of full scale
RECORDER OUTPUT ≤0.25% of full scale

PULSE-PAIR RESOLUTION
Negative input ≤10 nsec
Positive input ≤40 nsec

COUNTING RATE
Negative input ≥100 MHz
Positive input ≥25 MHz

CONTROLS AND DISPLAYS

DISPLAY Edgewise meter on front panel with three linear scales; 0 to 2.5, 0 to 5, and 0 to 10. Meter has built-in mechanical zero.

RANGE Front-panel 3-position toggle switch selects full-scale ranges of 2.5, 5, and 10 counts per second. Operates in conjunction with the MULTIPLIER switch to determine full scale counts per second.

MULTIPLIER Front-panel 8-position rotary switch selects the range multiplier of 1, 10, 10^2, 10^3, 10^4, 10^5, 10^6, or 10^7 for total full scale ranges of from 2.5 to 100,000,000 counts per second.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 526
100 MHz Ratemeter

RAPID CHARGE LED indicates when the unit is in the RAPID CHARGE mode as invoked upon power-up or by releasing the RESET button. In this mode the unit will respond from 0 to ±5% of the actual count rate 4 to 400 times faster than if this mode was not invoked. The RAPID CHARGE feature provides for quick settling times when for example small standard deviation and low count rates are selected.

% STD. DEV. Front-panel 3-position switch selects percent standard deviation of .5, 1.5, and 5% at full scale.

RESET Front-panel push-button resets the meter and output to 0 and invokes the RAPID CHARGE mode upon release.

OUTPUT RANGE PCB mounted jumper selects 100 mV, 1 V, or 10 V full scale for the rear-panel recorder output.

INPUTS

POS IN Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ±25 V. Input amplitude must exceed the 1.25 V fixed threshold level for 20 nsec. Pulse-pair resolution ≤40 nsec; input impedance 1 k ohms; dc-coupled.

NEG IN Front- and rear-panel BNC connectors accept standard negative NIM signals nominally 16 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at −150 mV; pulse-pair resolution ≤10 nsec; input impedance 50 ohms; dc-coupled.

OUTPUT

OUTPUT Rear-panel BNC connector for connection to strip chart recorder or other analog recording devices. An easily removed PCB jumper selects full scale output of 100 mV, 1 V, or 10 V; output impedance 50 ohms.

ORDERING INFORMATION

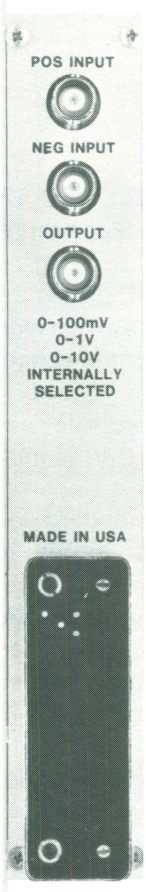
POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 160 mA
−24 V, 0 mA; −12 V, 50 mA

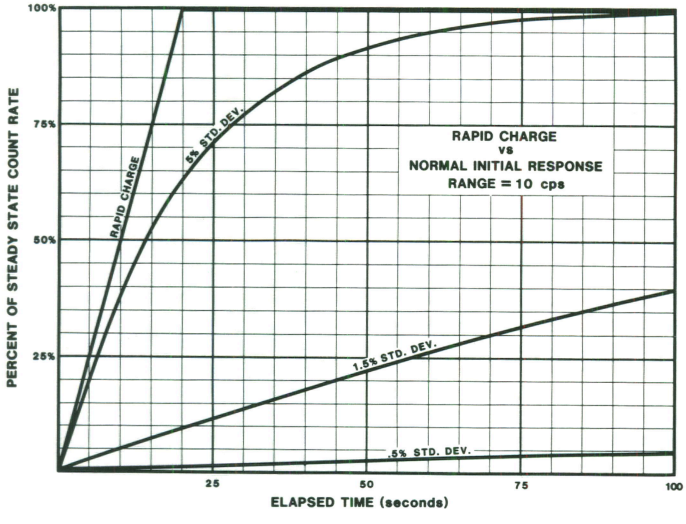
WEIGHT
(SHIPPING) 5 lbs. (2.3 kg)
(NET) 2 lbs. 10 oz. (1.19 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.





TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 526 10.0K 584

TENNELEC

TC 527
100 MHz Audible Log/Linear Ratemeter

DESCRIPTION

The TENNELEC TC 527 is a **100 MHz Log and Linear Ratemeter**, with a count rate dependent **audible output** housed in a double-wide NIM module. The linear section of the TC 527 offers an unprecedented 15 full-scale ranges from 10 counts per second to 100,000,000 counts per second in a 1-3-10 sequence. The logarithmic section covers seven decades and will display any five-decade span of count rates from 10^1 to 10^8 counts per second.

Two front-panel meters allow the user to simultaneously monitor the input count rate on both the log and linear range.

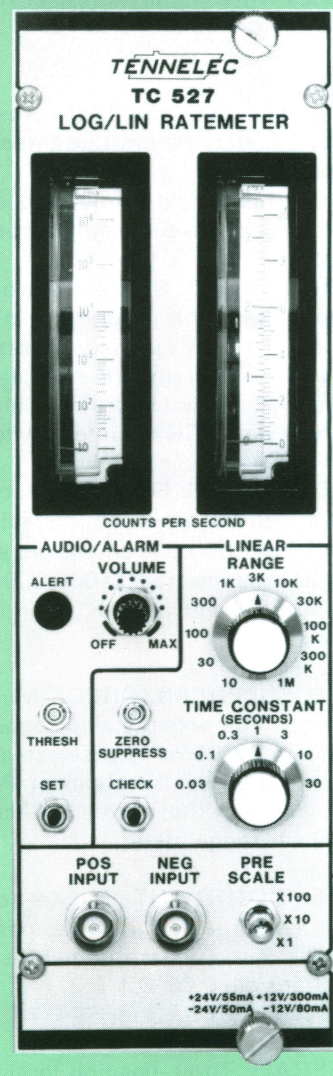
The TC 527 also provides two independent, **simultaneous recorder outputs from the log and linear sections**, selectable as 100 mV, 1V or 10V full scale.

In situations where the count rate of an experiment is difficult to visually monitor, the TC 527 offers an **audible frequency indication of count rate with threshold and volume controls.**

Zero suppression is provided for up to 100% of any linear range. This feature allows the user to subtract a constant background from the input data so that only true counts are displayed on the linear meter and true count data rates are transmitted to the linear recorder output.

Seven linear time constants are provided, enabling the user to select the ratemeter response time appropriate to the variability and magnitude of the input count rate.

- **100 MHz log and linear**
- **Audible output**
- **Two front-panel meters**
- **Simultaneous log and linear recorder outputs**
- **Up to 100% zero suppression**
- **Seven linear time constants**



SPECIFICATIONS

PERFORMANCE

LINEAR RANGES 15 ranges from 10 to 100,000,000 counts per second full scale in a 1-3-10 sequence with a X1, X10 and X100 prescaler.

LOGARITHMIC RANGES 10 to 100,000,000 counts per second in any five-decade span with a X1, X10 and X100 prescaler.

TEMPERATURE INSTABILITY
Log: ≤±0.1% of full scale per °C;
Linear: ≤±0.05% of full scale per °C, 0 to 50°C

ACCURACY at 25°C
RECORDER OUTPUT (10V full scale)
Linear ≤±0.1% of full scale
Log ≤±0.25% of full scale

METER
Linear ≤±2%, full scale deflection
Log ≤±2%, full scale deflection

PULSE-PAIR RESOLUTION
Negative input ≤10 nanoseconds
Postive input ≤40 nanoseconds

COUNTING RATE
Negative input ≥100 MHz
Positive input ≥25 MHz

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 527 100 MHz Audible Log/Linear Ratemeter

ZERO SUPPRESSION 0 to 100% of full scale for selected linear range

AUDIO OUTPUT A tone of variable frequency is provided through a rear-panel mounted speaker. The frequency increases in correspondence with the selected count rate meter's deflection, once the Audio/Alarm threshold is exceeded.

DISPLAYS and CONTROLS

DISPLAYS Two front-panel, edgewise mounted meters are provided. The logarithmic meter is divided into five log decades while the linear meter has two scales; 0 to 3.33 and 0 to 10.

AUDIO/ALARM

ALERT Front-panel LED lights when the audio/alarm count rate threshold is exceeded.

VOLUME Single-turn control adjusts the volume of the audio output from off to maximum.

THRESHOLD/SET Multi-turn potentiometer sets the Audio/Alarm count rate threshold by pushing the **set** pushbutton and observing the needle deflection on either the log or linear meter as selected via a PCB mounted switch.

LINEAR RANGE Eleven-position rotary switch selects linear counts full scale from 10 to 1,000,000 counts per second. Ranges expanded to 100,000,000 counts per second with the X10 and X100 prescaler.

ZERO SUPPRESS/CHECK Multi-turn potentiometer sets the zero suppression from 0 to 100% of the selected linear range by pressing the **check** pushbutton and observing the needle deflection on the linear range meter.

TIME CONSTANT Seven-position rotary switch selects the time constant in seconds of the linear ratemeter section; selections are 0.03, 0.1, 0.3, 1, 3, 10 and 30 seconds.

PRESCALE Three-position locking toggle switch selects a prescale factor of X1, X10 or X100. Multiplies the Linear and Logarithmic meter reading by 1, 10 or 100 respectively.

INPUTS

POS INPUT Front- and rear-panel BNC connectors accept unipolar, bipolar or NIM positive logic pulses to ±30V. Input amplitude must exceed fixed 1.25V threshold level for 20 nsec. Input impedance 3.5k ohms, dc-coupled.

NEG INPUT Front- and rear-panel BNC connectors accept NIM negative logic pulses, nominally 16 mA into 50 ohms. Input amplitude must exceed fixed –0.25V threshold level for 4 nsec. Input impedance 50 ohms, dc-coupled.

OUTPUTS

RECORDER OUTPUT

LINEAR Rear-panel BNC connector provides an output from the linear section for a strip chart or other analog recording device. An internal programming jumper selects full-scale output of 100mV, 1V or 10V; output impedance 50 ohms.

LOG Rear-panel BNC connector provides an output from the log section for a strip chart or other analog recording device. An internal programming jumper selects full-scale output of 100mV, 1V or 10V with a 20mV, 0.2V or 2V per decade characteristic; output impedance 50 ohms.

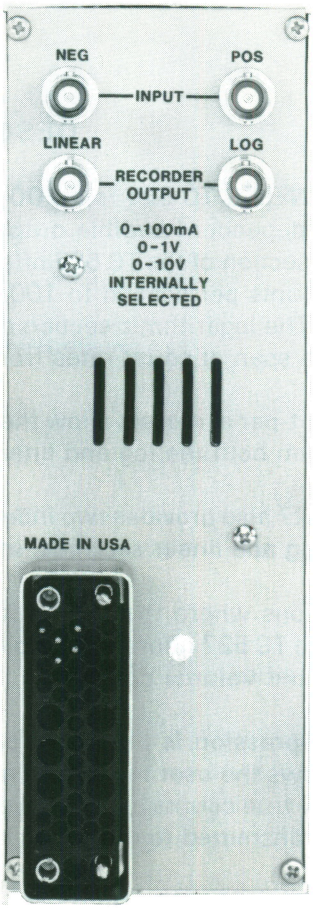
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 55 mA; +12 V, 300 mA
–24 V, 50 mA; –12 V, 80 mA (Audio off)
300 mA (Audio Max)

WEIGHT (SHIPPING) 4.0 lbs. (1.8 kg)
(NET) 2.0 lbs. (0.9 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TC 527 10.0K 984

TENNELEC

TC 529
Alarm Control

DESCRIPTION

The TENNELEC Model TC 529 Alarm Control is a single-width NIM module which generates an alarm signal and energizes relay contacts when the ratemeter input falls outside of two alarm set points or count rate limits. The TC 529 connects to the recorder output of a linear or logarithmic ratemeter and monitors the systems count rate.

Two independent alarm set points are provided on the TC 529. In addition, two operational modes may be selected via a printed circuit board mounted switch. **Window or dual discriminator operating modes** are available.

Mode 1: In mode 1, the TC 529 operates in the **window mode** where discriminator A is set below the minimum acceptable input count rate and discriminator B is set above the maximum acceptable input count rate. If the input count rate falls below discriminator A or goes above discriminator B, **separate discriminator outputs** are generated. An **Alarm output** is also generated when the input count rate falls below discriminator A or rises above discriminator B.

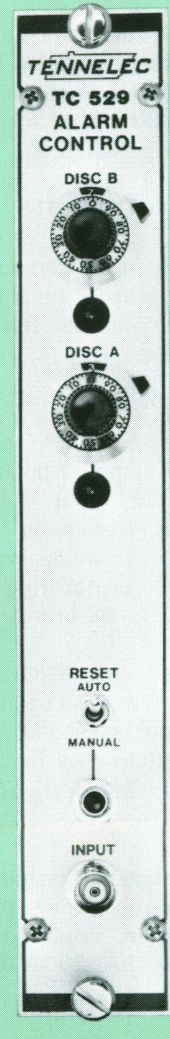
Mode 2: In mode 2, or **dual discriminator mode**, discriminators A and B are independently adjustable and generate respective outputs when their input count rate levels are exceeded. Discriminator A is normally set at a warning level and discriminator B is then set at a higher, more critical input count rate level. The Alarm outputs functions the same as in Mode 1.

Relay contacts for the control of other devices are provided in the TC 529. Normally open (NO) and normally closed (NC) contacts energize under the same conditions that generates an Alarm output.

A front-panel toggle switch allows selection of either **automatic or manual reset modes.** In the automatic reset mode, the alarm state will be reset when the original alarm condition no longer exists. In the manual mode, an alarm state will persist until the manual reset push button is pressed.

The TC 529 offers a selectable **0-1 volt or 0-10 volt ratemeter input range.** This allows it to be compatible with virtually any ratemeter and to control alarms or other devices based upon the total system count rate.

- **Two independent alarm set points**
- **Window or dual discriminator operating modes**
- **Separate discriminator outputs**
- **Alarm output**
- **Relay contacts for control of other devices**
- **Manual or automatic reset modes**
- **0-1 volt or 0-10 volt ratemeter input range**



SPECIFICATIONS

PERFORMANCE

RESPONSE TIME Less than 10 μsec after the input signal crosses the set point; less than 10 msec for relay outputs.

DISCRIMINATOR SET POINT
Inaccuracy $< \pm$ 1% of full-scale

TEMPERATURE INSTABILITY
$<$ 0.01%/°C, 0 to 50°C

NONLINEARITY $<$ 0.5% of full-scale

CONTROLS

DISC B A ten-turn precision potentiometer selects the setpoint for discriminator B. 0 to 1 volt or 0 to 10 volts as selected by PCB mounted switch.

DISC A A ten-turn precision potentiometer selects the setpoint for discriminator A. 0 to 1 volt or 0 to 10 volts as selected by PCB mounted switch.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 529 Alarm Control

RESET AUTO/MANUAL Two-position toggle switch selects automatic or reset mode. In auto reset, an alarm condition will be reset when the alarm state is no longer present. In the manual mode, an alarm condition will be maintained until the manual reset push button is pressed.

RANGE A PCB mounted slide switch selects either a 0 to 10 V or 0 to 1 V input range.

MODE A PCB mounted selector controls the response mode for the discriminator A output. Discriminator A can be set to be triggered by an input level higher than the set point or lower than the set point.

INPUTS

INPUT Front- and rear-panel BNC connectors accept an analog output from a ratemeter. Approximate range is either 0 to +10 V or 0 to +1 V according to PCB mounted slide switch; Z_{in} = 1k ohms.

OUTPUTS

DISC B Rear-panel BNC connector provides a NIM-standard positive logic output when discriminator B is triggered; 0 V for not triggered, +5 V for triggered; Z_{out} = 50 ohms.

DISC A Rear-panel BNC connector provides a NIM-standard positive logic output when the input falls below the discriminator level (mode 1) or when the input exceeds the discriminator level (mode 2). 0 V for not triggered, +5 V for triggered; Z_{out} = 50 ohms.

ALARM Rear-panel BNC connector provides a NIM-standard positive logic output when input is less than discriminator A or greater than discriminator B; 0 V for not triggered, +5 V for triggered; Z_{out} = 50 ohms.

RELAY Rear-panel terminal strip furnishes the connections to the contacts of the single pole, double throw (SPDT) internal relay. 5A, 250 VAC, noninductive rating.

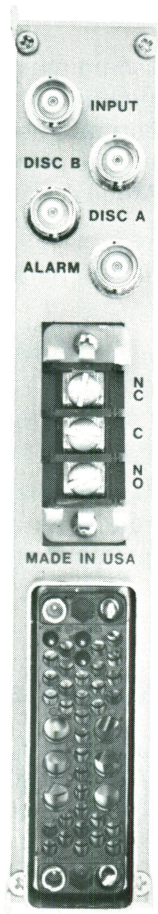
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 150 mA
−24 V, 0 mA; −12 V, 25 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.0 lbs. (.91 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (REV.).

INSTRUCTION MANUAL One provided with each instrument ordered.

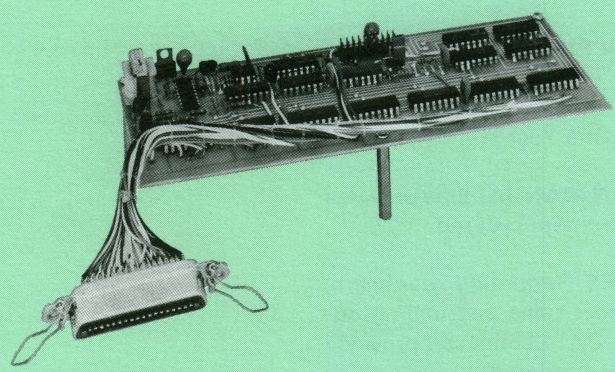


TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TC 529 10.0K 885

TENNELEC

TC 530–01
Parallel Output Option



- Provides parallel BCD data
- Buffered for fast data transfer
- Field installable

DESCRIPTION

The TENNELEC TC 530-01 is a **Buffered, Parallel BCD Data** Output Option designed for use with the TENNELEC TC 532 and TC 533 Counters and the counter of the TC 534 Counter and Timer.

The TC 530-01 provides the user the ability to transfer counter data in a rapid parallel fashion to computers, mass-storage devices, etc., without interrupting any of the other standard functions of the host counter. The TC 530-01 board mounts directly to the main printed circuit board of the counter. The mounting holes necessary for this installation are provided on the Tennelec counter board, making this option easily **field installable.**

The TC 530-01 is provided with a wired 36-pin connector which mounts in the option position on the rear panel of the counter, a mating 36-pin connector (Amphenol 57-30360), mounting hardware and an interconnect cable to the counter PC board. NOTE: The installation of this option by Tennelec is not included in the TC 530-01 price.

SPECIFICATIONS

PERFORMANCE

BUFFER CAPACITY Seven decades (9,999,999) plus one overflow bit

DATA ACQUISITION TIME $<75\ \mu s$ (65 μs typical) total for all seven decades

CONTROLS

STORE A two-position programming pin allows the user to select the source of the STORE command.

OUTPUT

PARALLEL DATA A 36-pin connector (Amphenol 57-40360) which contains the 28 bits of BCD data, overflow bit, and system and interface signals. The connector is mounted in the "OPTION" position on the rear panel of the module. All signals are TTL levels.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 530-01 Parallel Output Option

PIN ASSIGNMENTS

PINS 1-28 Tri-state parallel data output lines. Data is output as seven decades in a BCD format.

PIN 29 Tri-state OVERFLOW data output line.

PIN 30 Ground

PIN 31 Open collector, passive pull-up Parallel Data Valid (PDV) control line. This line indicates that the TC 530-01 has acquired the data from the counter. (Data not Valid: PDV $\leqslant$ 0.4 V; Data Valid: PDV $\geqslant$ 2.4 V). The PDV line from several counters can be "wire ORed" to form an overall system data valid control signal.

PIN 32 Parallel Output Enable (POE) control input. This line controls the mode of the data and overflow output lines (Outputs Driven: POE $\leqslant$ 0.8 V; Outputs Tri-stated: POE $\geqslant$ 2.0 V). This line also controls data storage when the STORE jumper is in the POE position.

PIN 33 EXT STORE control input. This line controls data storage when the STORE jumper is in the EXT position.

PIN 34 SYSTEM PRESET control line. This line indicates that a module has reached a preset (Preset Reached $\leqslant$ 1.5 V; No Preset $\geqslant$ 3.0 V).

PIN 35 SYSTEM GATE control line. This line allows the counter to be gated off from an external source (Gated Off $\leqslant$ 1.5 V; Gated On $\geqslant$ 3.0 V).

PIN 36 SYSTEM RESET control line. This line allows the counter to be reset from an external source (Reset $\leqslant$ 1.5 V; No Reset $\geqslant$ 3.0 V).

ORDERING INFORMATION

POWER REQUIRED All power is supplied by the host module.
+24 V, 70 mA; +12 V, 0 mA
-24 V, 0 mA; -12 V, 0 mA

WEIGHT (SHIPPING) 3 lbs. (1.36 kg)
(NET) 1 lb. (0.45 kg)

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES Mounting hardware, PCB interconnect cable and mating 36-pin PARALLEL DATA connector provided with each option ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TENNELEC

TC 53
Counte

DESCRIPTION

The **TENNELEC TC 531** Counter is the first of a series of **high performance low cost** counters offered by **TENNELEC**.

The most immediately recognizable feature of the **TC 531** is its pulse count rate capability. The **TC 531** will count **negative input** pulses at a rate of 100 million counts per second **(100 MHz)**, and **positive input** pulses at a rate of 25 million counts per second **(25 MHz)**. The fast negative NIM pulse can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

A **discriminator** is provided for the **positive input** and is **adjustable** over the range of + **0.1 to** + **10 V.** This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted.

A **six-decade**,seven-segment **LED display** is featured in the **TC 531. Leading zero's are suppressed** presenting only the data in an easily-read format. A front-panel **TEST pushbutton** is provided to verify that the LED's are working by displaying all "8's".

Counting can be electronically halted with the **GATE input**, or manually halted with a COUNT/STOP toggle switch. A **front-panel GATE LED** illuminates whenever the **TC 531** is enabled to count, both manually and electronically. **TENNELEC** Timers provide the appropriate signal to control the counting of the **TC 531**.

Should the **TC 531** six-decade counter capacity ever be exceeded, all six decades will reset to zero, an **OVERFLOW LED** will illuminate and a **standard logic signal** will be **generated** through a rear-panel BNC connector. This signal is directly compatible with any of **TENNELEC's** counters.

- **High Performance, low cost**
- **100MHz negative and 25 MHz positive input counting capability**
- **Adjustable positive input discriminator**
- **Six-decade LED display with leading zeros suppressed and test push-button**
- **Gate input and overflow output with LED indicators**

SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Six decades (999,999)

COUNTING RATE 100 MHz negative input; 25 MHz positive input

PULSE PAIR RESOLUTION Negative input 10 nsec; Positive input 40 nsec.

INPUT DISCRIMINATOR Negative input fixed at −250 mV. Positive input variable from + 0.1 to + 10 volts.

CONTROLS AND INDICATORS

DISPLAY Six decades of seven-segment 0.11 inch LED digits.

OVERFLOW Front-panel LED illuminates when overflow condition is met.

GATE Front-panel LED illuminates when counter is gated on and when unit is in the normal counting condition.

TEST Front-panel push button lights all seven segments of each LED when pressed, displaying 888888.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 531 Counter

DISCRIMINATOR Single-turn potentiometer on the front panel sets the discriminator level for the positive input from + 0.1 to + 10 V.

RESET Front-panel push button resets display and internal registers to the initial zero condition.

COUNT/STOP Toggle switch on the front panel selects counting (COUNT) or non-counting (STOP) condition.

CONNECTORS

+ INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ± 25 V. Input amplitude must exceed the adjusted threshold level for 20 nsec. Pulse-pair resolution ⩽ 40 nsec; input impedance 1K ohms; dc-coupled.

– INPUT Front- and rear-panel BNC connectors accept NIM standard fast negative logic signals; 14 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at –250 mV; pulse-pair resolution ⩽ 10 nsec; input impedance 50 ohms; dc-coupled.

GATE BNC connectors on front and rear panels accept NIM standard positive logic signals to control the counter gate. Open circuit or ⩾+3 volts to allow counting; ⩽+1.5 volts to inhibit counting.

EXT RESET A rear-panel BNC connector accepts a NIM standard logic signal (+5 V, 500 nsec wide) or a momentary ground to reset the counter to an initial zero condition. An internal programming pin allows the operator to select which condition is required for external reset. Active low: ⩽+1.5 V or short to ground for reset, ⩾+3 V or open circuit for non-reset. Active high: ⩾+3 V for reset, ⩽+1.5 V for non-reset.

OVERFLOW OUT Rear-panel BNC connector furnishes a NIM standard positive logic signal, 2 μsec wide, whenever the counter overflows (999,999). Output impedance ⩽ 10 ohms, dc-coupled.

ORDERING INFORMATION

POWER +24 V, 80 mA; +12 V, 165 mA
–24 V, 0 mA; –12 V, 70 mA

WEIGHT
(SHIPPING) 4 lbs. (1.81 kg)
(NET) 1 lb. 12 oz. (0.8 kg)

DIMENSIONS Standard Single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018
TC 531 10.0K 286

TENNELEC

TC 532
Counter

DESCRIPTION

The TENNELEC Model TC 532 is a **high-performance, low-cost** counter designed for high speed data acquisition.

The most immediately recognizable feature of the TC 532 is its pulse-countrate capability. The TC 532 will count **negative input** pulses at a rate of **100 million counts per second (100 MHz),** and **positive input** pulses at a rate of **25 million counts per second (25 MHz).** The fast negative NIM pulse can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

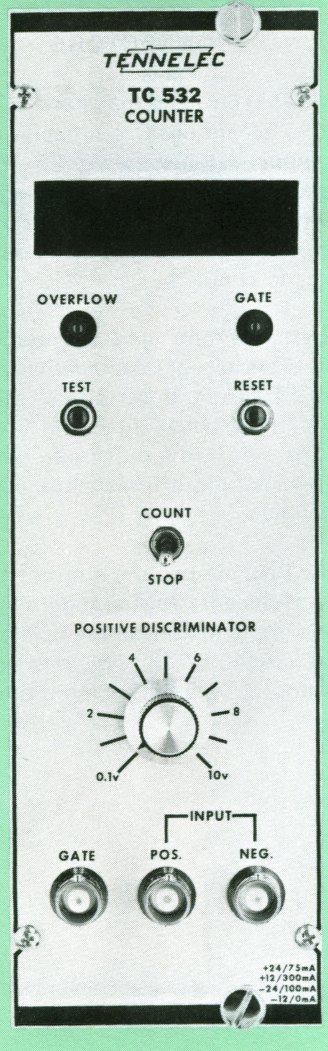
A **discriminator** is provided for the **positive input** and is **adjustable** over the range of + 0.1 to + 10V. This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted. A **seven-decade,** seven-segment **LED display** is featured in the TC 532. **Leading zero's are suppressed** presenting only the data in an easily-read format. A front-panel TEST pushbutton is provided to verify that the LED's are working by displaying all "8's".

Counting can be electronically halted with the **GATE input,** or manually halted with a COUNT/STOP toggle switch. A **front-panel GATE LED** illuminates whenever the TC 532 is enabled to count, both manually and electronically. TENNELEC Timers provide the appropriate signal to control the counting of the TC 532.

Should the TC 532 seven-decade counter capacity ever be exceeded, all seven decades will reset to zero, an **OVERFLOW LED** will illuminate and a **standard logic signal** will be **generated** through a rear-panel BNC connector. This signal is directly compatible with any of the TENNELEC counters.

Provisions have been made to allow the counters' data to be output in a parallel fashion. An optional **Parallel Data Output** provides buffered data transfer, with all seven decades being transferred simultaneously over 28 BCD data lines. In addition, this option also provides control and strobe lines for operation with high speed printers and computer-based systems.

- **High Performance, Low-Cost Counter**
- **100 MHz negative and 25 MHz positive input**
- **Seven-decade LED display with leading zeros suppressed and test push-button**
- **Adjustable positive input discriminator**
- **Gate input and overflow output with LED indicators**
- **Parallel output option**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Seven decades (9,999,999).

COUNTING RATE 100 MHz negative input; 25 MHz positive input.

PULSE PAIR RESOLUTION Negative input 10 nsec; Positive input 40 nsec.

INPUT DISCRIMINATOR Negative input fixed at -250 mV. Positive input variable from +0.1 to +10 volts.

CONTROLS AND INDICATORS

DISPLAY Seven decades of seven-segment LED digits.

OVERFLOW Front-panel LED illuminates when overflow condition is met.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 532 Counter

GATE Front-panel LED illuminates when counter is gated on and when unit is in the normal counting condition.

TEST Front-panel push button lights all seven segments of each LED when pressed, displaying 8888888.

DISCRIMINATOR Single-turn potentiometer on the front panel sets the discriminator level for the positive input from +0.1 to +10V.

RESET Front-panel push button resets display and internal registers to the initial zero condition.

COUNT/STOP Toggle switch on the front panel selects counting (COUNT) or noncounting (STOP) condition.

CONNECTORS

+ INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ± 25 V. Input amplitude must exceed the adjustable threshold level for 20 nsec. Pulse-pair resolution ⩽ 40 nsec; input impedance 1k ohms; dc-coupled.

— INPUT Front- and rear-panel BNC connectors accept fast negative logic signals, 14 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at —250 mV; pulse-pair resolution ⩽ 10 nsec; input impedance 50 ohms; dc-coupled.

GATE BNC connectors on front and rear panels accept NIM-standard positive logic signals to control the counter gate. Open circuit or ⩾ + 3 volts to allow counting; ⩽ + 1.5 volts to inhibit counting.

EXT RESET A rear-panel BNC connector accepts a NIM-standard positive logic signal (500 nsec wide) or a momentary ground to reset the counter to an initial zero condition. An internal programming pin allows the operator to select which condition is required for external reset. Active low: ⩽ + 1.5 V or short to ground for reset, ⩾ + 3 V or open circuit for non-reset. Active high: ⩾ + 3 V for reset, ⩽ + 1.5 V for non-reset.

OVERFLOW OUT Rear-panel BNC connector furnishes a NIM-standard positive 2 μsec wide pulse whenever the counter overflows (9,999,999). Output impedance ⩽ 10 ohms, dc-coupled.

OPTION Rear-panel 36-pin connector. Used to output data in a parallel fashion, 28 BCD bits of data are available simultaneously.

ORDERING INFORMATION

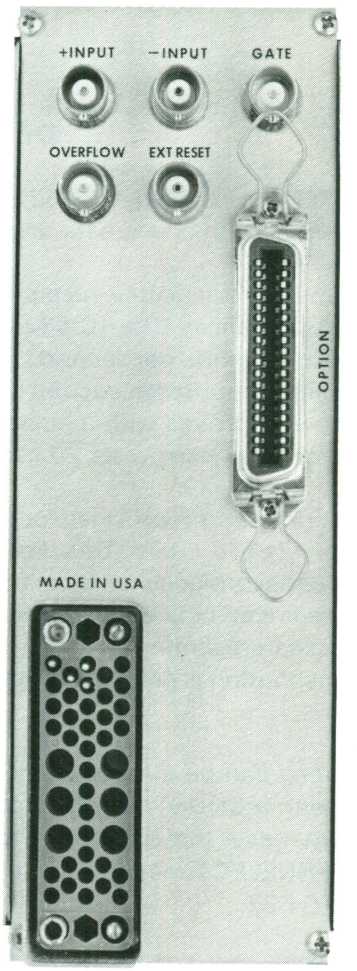
POWER REQUIREMENTS
+24 V, 75 mA; +12 V, 300 mA
-24 V, 0 mA; -12 V, 100 mA

WEIGHT (SHIPPING) 4 lbs. (1.81 kg)
(NET) 1 lb. 12 oz. (0.8 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 532 10.0K 882

TENNELEC

TC 53
Count

DESCRIPTION

The **TENNELEC** Model **TC 533** is a **high-performance, low-cost printing counter** designed for high speed data acquisition.

The most immediately recognizable feature of the **TC 533** is its pulse-count rate capability. The **TC 533** will count **negative input** pulses at a rate of **100 million counts per second (100 MHz),** and **positive input** pulses at a rate of **25 million counts per second (25 MHz)**. The fast negative NIM pulse can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

A **discriminator** is provided for the **positive input** and is **adjustable** over the range of +0.1 to +10 V. This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted.

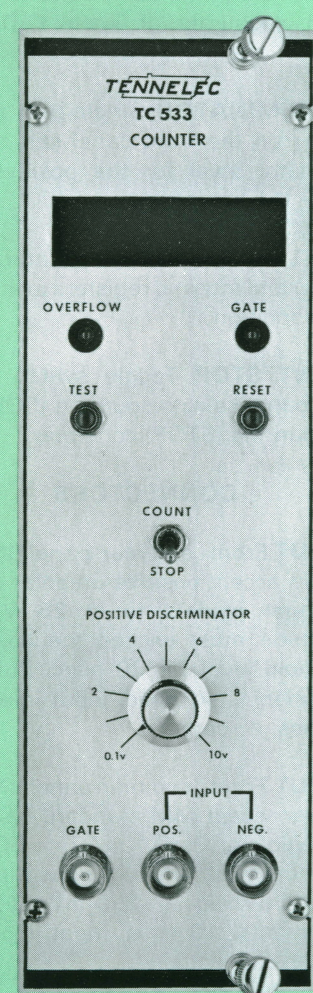
A **seven-decade**, seven-segment **LED display** is featured in the **TC 533. Leading zero's are suppressed** presenting only the data in an easily-read format. A front-panel **TEST push button** is provided to verify that the LEDs are working by displaying all "8"s.

Counting can be electronically halted with the **GATE input**, or manually halted with a COUNT/STOP toggle switch. A **front-panel GATE LED** illuminates whenever the **TC 533** is enabled to count, both manually and electronically. **TENNELEC** Timers provide the appropriate signal to control the counting of the **TC 533**.

Should the **TC 533** seven-decade counter capacity ever be exceeded, all seven decades will reset to zero, an **OVERFLOW LED** will illuminate and a **NIM-standard logic signal** will be **generated** through a rear-panel BNC connector. This signal is directly compatible with any of the **TENNELEC** counters.

The **TC 533** may be incorporated into a complete data acquisition system with other **TENNELEC** or ORTEC printing modules as it is compatible with all existing units. In addition, provisions have been made to allow the counters' data to be output in a parallel fashion. An optional **Parallel Data Output** provides batch data transfer, with all seven decades being transferred simultaneously over 28 BCD data lines. In addition, this option also provides control and strobe lines for operation with high speed printers and computer-based systems.

- **High Performance, Low-Cost Printing Counter**
- **100 MHz negative and 25 MHz positive input**
- **Adjustable positive input discriminator**
- **Seven-decade LED display with leading zeros suppressed and test push button**
- **Gate input and overflow output with LED indicators**
- **Parallel output option**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Seven decades (9,999,999).

COUNTING RATE 100 MHz negative input; 25 MHz positive input.

TC 533 Counter

PULSE PAIR RESOLUTION Negative input 10 nsec; positive input 40 nsec.

INPUT DISCRIMINATOR Negative input fixed at –250 mV. Positive input variable from + 0.1 to + 10 volts.

CONTROLS AND INDICATORS

DISPLAY Seven decades of seven-segment LED digits.

OVERFLOW Front-panel LED illuminates when overflow condition is met.

GATE Front-panel LED illuminates when counter is gated on and when unit is in the normal counting condition.

TEST Front-panel push button lights all seven segments of each LED when pressed, displaying 8888888.

DISCRIMINATOR Single-turn potentiometer on the front panel sets the discriminator level for the positive input from + 0.1 to + 10 V.

RESET Front-panel push button resets display and internal registers to the initial zero condition.

COUNT/STOP Toggle switch on the front panel selects counting (COUNT) or noncounting (STOP) condition.

CONNECTORS

+ INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ± 25 V. Input amplitude must exceed the adjustable threshold level for 20 nsec. Pulse-pair resolution ⩽ 40 nsec; input impedance 1k ohms; dc-coupled.

– INPUT Front- and rear-panel BNC connectors accept NIM-standard fast negative logic signals; 14 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at –250 mV; pulse-pair resolution ⩽ 10 nsec; input impedance 50 ohms; dc-coupled.

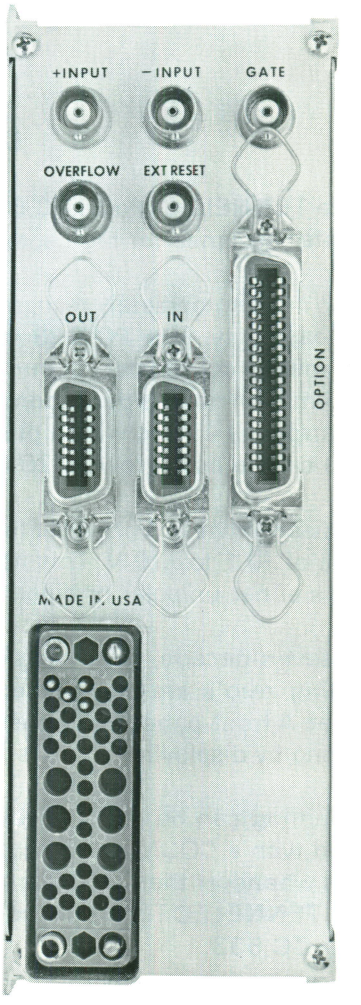
GATE BNC connectors on front and rear panels accept NIM-standard positive logic signals to control the counter gate. Open circuit or ⩾ + 3 volts to allow counting; ⩽ + 1.5 volts to inhibit counting.

EXT RESET A rear-panel BNC connector accepts a NIM-standard logic signal (0.5 μsec wide) or a momentary ground to reset the counter to an initial zero condition. An internal programming pin allows the operator to select which condition is required for external reset. Active low: ⩽+1.5 V or short to ground for reset, ⩾+3 V or open circuit for non-reset. Active high: ⩾+3 V for reset, ⩽+1.5 V for non-reset.

OVERFLOW OUT Rear-panel BNC connector furnishes a NIM-standard positive logic signal, 2 μsec wide, whenever the counter overflows (9,999,999). Output impedance ⩽ 10 ohms; dc-coupled.

IN/OUT Rear-panel 14-pin connectors for use with TENNELEC or ORTEC standard printing system.

OPTION Rear-panel 36-pin connector. Used to output data in a parallel fashion, 28 BCD bits of data are available simultaneously, via TC 530-01.



ORDERING INFORMATION

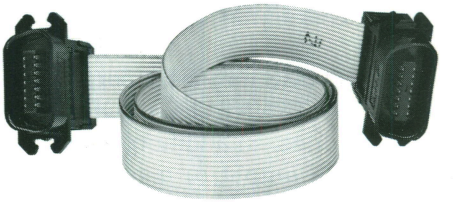
POWER REQUIREMENTS
+24 V, 100 mA; +12 V, 300 mA
–24 V, 0 mA; –12 V, 100 mA

WEIGHT (SHIPPING) 4.0 lbs. (1.8 kg)
(NET) 1.75 lbs. (0.8 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED Printing system control cable (NC-ODA-2) for use with TENNELEC or ORTEC standard printing loop.



NC-ODA-2

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 533 10.0K 686

TENNELEC

TC 534
Counter and Timer

DESCRIPTION

The TENNELEC Model TC 534 is a high performance, **printing counter and timer** designed for high speed data acquisition.

The counter section of the TC 534 will count negative input pulses at a rate of **100 million counts per second (100 MHz)** and **positive input pulses at a rate of 25 million counts per second (25 MHz).**

The fast negative NIM pulse can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

A **discriminator is provided for the positive input** and is adjustable over the range of + 0.1 to + 10V. This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted. A **seven-decade,** seven-segment LED display is featured in the TC 534. Leading zero's are suppressed presenting only the data in an easily-read format. A front-panel TEST pushbutton is provided to verify that the LED's are working by displaying all "8's".

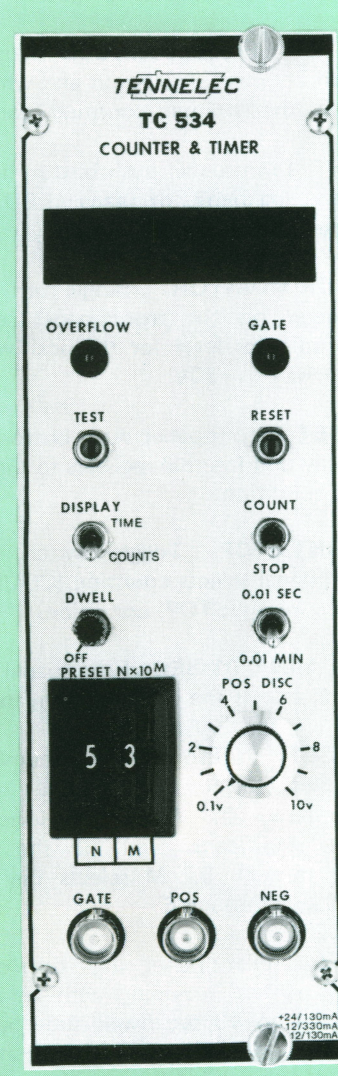
Counting can be electronically halted with the GATE input, or manually halted with a COUNT/STOP toggle switch. A front-panel LED illuminates whenever the TC 534 is enabled to count, both manually and electronically.

The Timer section of the module is designed as an accurate timer for any counting experiment. The timebase for the TC 534 is **crystal controlled** which allows for less than 0.0005% inaccuracy.

The Timer section of the module can be operated in the single cycle or recycle mode.

The TC 534 may be incorporated into a complete data acquisition system with other TENNELEC or ORTEC printing modules as it is compatible with all existing units. In addition, provisions have also been made to allow the counter's data to be output in a parallel fashion. An optional Parallel Data Output provides batch data transfer, with all seven decades being transferred simultaneously over 28 BCD data lines. In addition, this option also provides control and strobe lines for operation with high speed printers and computer-based systems.

- **7-decade LED display**
- **Simultaneous Counter and Timer operation**
- **100 MHz negative and 25 MHz positive input counting capability**
- **Adjustable positive input discrimination**
- **Crystal controlled time base**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Seven decades (9,999,999).

COUNTING RATE 100 MHz negative input; 25 MHz positive input.

PULSE PAIR RESOLUTION Negative input 10 nsec; Positive input 40 nsec.

INPUT DISCRIMINATOR Negative input fixed at −250 mV. Positive input variable from +0.1 to +10 volts.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 534 Counter and Timer

TIMEBASE 10 MHz crystal-controlled oscillator; inaccuracy <0.0005%; temperature instability <0.0002%/°C for 0 to 50°C.

TIME PRESETS 0.01 to 90,000 sec; 0.01 to 90,000 min.

OPERATING TEMPERATURE 0 to 50°C.

CONTROLS AND INDICATORS

DISPLAY Seven decades of seven-segment LED digits.

OVERFLOW Front-panel LED illuminates when overflow condition is met.

GATE Front-panel LED illuminates when counter is gated on and when unit is in the normal counting condition.

TEST Front-panel push button lights all seven segments of each LED when pressed, displaying 8888888.

DISCRIMINATOR Single-turn potentiometer on the front panel sets the discriminator level for the positive input from +0.1 to +10V.

RESET Front-panel push button resets display and internal registers to the initial zero condition.

COUNT/STOP Toggle switch on the front panel selects counting (COUNT) or noncounting (STOP) condition.

0.01 MIN/0.01 SEC Front-panel toggle switch selects the rate of timing markers.

PRESET Front-panel thumbwheel switches select preset time interval in a N x 10^M format. N selects the most significant digit of the preset as 0 through 9. M selects the power of 10 as 0 through 6.

DWELL Front-panel single-turn control allows system recycling with an adjustable 0.1 to 10 sec dwell time between counting intervals. An OFF position is provided to inhibit the recycle operation.

DISPLAY Toggle switch selects the register whose contents will be displayed, either Counts or Time.

CONNECTORS

+ INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ± 25V. Input amplitude must exceed the adjustable threshold level for 20 nsec. Pulse-pair resolution ⩽ 40 nsec; input impedance 1K ohms; dc-coupled.

– INPUT Front- and rear-panel BNC connectors accept fast negative logic signals, 14 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at –250 mV; pulse-pair resolution ⩽ 10 nsec; input impedance 50 ohms; dc-coupled.

GATE BNC connectors on front and rear panels accept standard positive logic signals to control the counter gate. Open circuit or ⩾ +3 volts to allow counting; ⩽ + 1.5 volts to inhibit counting.

EXT RESET A rear-panel BNC connector accepts a standard logic signal (+5V, 500 nsec wide) or a momentary ground to reset the counter to an initial zero condition. An internal programming pin allows the operator to select which condition is required for external reset. Active low: ⩽ + 1.5V or short to ground for reset, ⩾ + 3V or open circuit for non-reset. Active high: ⩾ + 3V for reset, ⩽ +1.5V for non-reset.

OVERFLOW OUT Rear-panel BNC connector furnishes a +5 volt, 2 μsec wide pulse whenever the counter overflows (9,999,999). Output impedance ⩽ 10 Ω, dc-coupled.

INTERVAL Rear-panel BNC connector which provides a NIM standard slow positive logic signal that is true only during each preset counting interval, ⩾ + 3V during timing interval, ⩽ + 1.5 V to inhibit counting.

TIME GATE Rear-panel BNC connector accepts NIM standard slow positive logic signals to gate the internal 10 MHz timebase oscillator off, ⩾ + 3V to gate timebase off, ⩽ + 1.5V to gate timebase on; time resolution = 100 nsec; Z_{in} = 10K ohms to ground. Connection of a system busy signal to the TIME GATE input provides for system dead time correction.

IN/OUT Rear-panel 14-pin connectors for use with TENNELEC or ORTEC standard printing systems.

OPTION Rear-panel 36-pin connector. Used to output data in a parallel fashion, 28 BCD bits of data are available simultaneously.

ORDERING INFORMATION

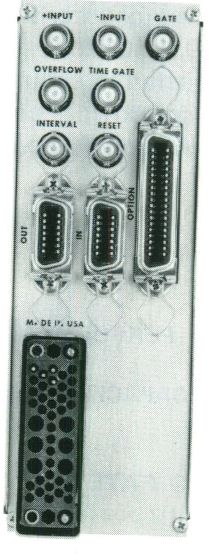
POWER REQUIREMENTS
+24V, 130 mA; +12V, 330 mA
–24V, 0 mA; –12V, 130 mA

WEIGHT
(SHIPPING) 4 lbs. (1.81 kg)
(NET) 1 lb. 12 oz. (0.8 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED Printing system control cable for use with TENNELEC or ORTEC standard printing loop.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 534 10.0K 985

TENNELEC

TC 535P
Multiscaler

DESCRIPTION

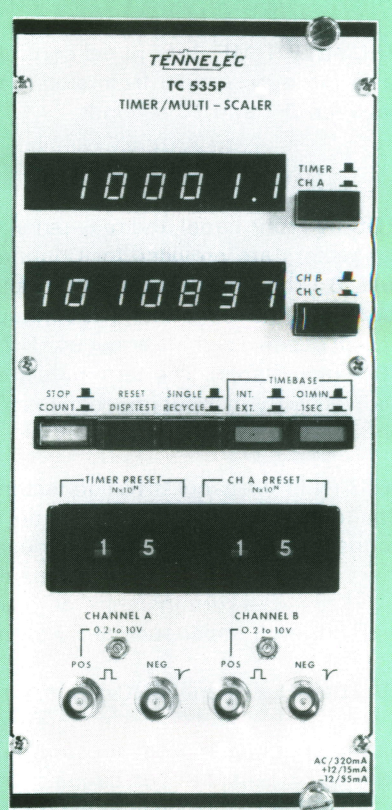
The **TENNELEC TC 535P** Multiscaler is a versatile nuclear timer/multiple counter packaged in a triple-width NIM module. The **TC 535P** includes three **85 MHz counting** channels and a highly **accurate crystal controlled timer.** The timer can also be used as an 85 MHz counting channel giving the **TC 535P** a **four-channel counting capacity.**

Data from all channels are shown on two **seven-decade LED displays**. The selection of channels to be displayed is made via two convenient pushbutton indicators.

The **TC 535P** is designed to be used either in a printing data acquisition system or as a stand-alone unit. The **print logic** is compatible with all **TENNELEC** printing data acquisition systems and those of most other manufacturers.

A **time gate** circuit is included to provide **dead time correction** using the busy signals from amplifiers, pileup rejectors, etc.

- **Seven-decade multi-counter/timer**
- **85 MHz guaranteed count rate**
- **Crystal timebase**
- **Full print logic**
- **Four channel counting capacity**
- **Dead time corrected**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY 9,999,999 ($1 \times 10^7 - 1$) counts per channel. By utilizing the overflow capability of the TC 535P, count capacity can be expanded to $1 \times 10^{28} - 1$ if necessary.

COUNT RATE 85 MHz (Positive and Negative inputs)

PULSE PAIR RESOLUTION 12 nsec

OPERATING TEMPERATURE 0 to 50°C

INPUT DISCRIMINATOR Negative input fixed at −250 mV. Positive input variable from +0.2 to +10 volts.

TIMEBASE INSTABILITY 0.001%/°C

CONTROLS AND INDICATORS

DISPLAY Two 7-decade LED displays indicate counts or time. The displays are switch selectable between pairs of channels. The upper display shows Time or Channel A, and the lower display shows Channel B or Channel C.

CHANNEL SELECTORS Indicator pushbuttons select between pairs of channels for the two displays.

STOP/COUNT Indicator pushbutton starts and stops the Multiscaler.

RESET/DISP. TEST Front-panel pushbutton resets the TC 535P and displays 8's on all decades.

SINGLE/RECYCLE Indicator pushbutton selects between single cycle or recycle modes of operation. In the single cycle mode the TC 535P will count to a preset and then stop. In the recycle mode the TC 535P will count to a preset, display the data, pause, reset all counters and timer and began counting again. The recycle (pause) time is adjustable between 0.1 and 10 seconds via a rear-panel control.

INT/EXT TIMEBASE Front-panel pushbutton controls timebase operation. In the INT position the TC 535P operates on the internal crystal controlled timebase. In EXT position the TC 535P operates on an external timebase or as an additional counter.

TC 535P Multiscaler

.01 MIN/.1 SEC TIMEBASE This indicator-pushbutton selects between .01 minute or .1 second timebase (the timebase can be further reduced by internal jumper).

A PRESET Two thumbwheels set the preset for Channel A. Preset is equal to N x 10^n counts.

TIMER PRESET Two thumbwheels set the preset for the time. The preset time is equal to N x 10^n x the timebase.

POSITIVE THRESHOLD Two front-panel pots adjust the positive input threshold between +0.2 V and +10 V for Channels A and B. Threshold adjustment for Channel C is located on the rear-panel.

RECYCLE TIME Rear-panel control adjusts the recycle time from stop to start between 0.1 and 10 seconds.

CONNECTORS

POS IN Front-panel and rear-panel BNC connectors are provided for Channels A and B. The Channel C BNC input is located on the rear panel. The connectors accept positive signals between +0.2 V to 10 V (adjustable). The terminals are dc-coupled with an input impedance of >1 k ohms.

NEG IN Front-panel BNC connectors for Channels A and B, and a rear-panel BNC connector for Channel C accept negative input signals with a fixed threshold of −250 mV. The terminals are dc-coupled with an input impedance of 50 ohms.

GATE IN Rear-panel BNC connectors for Channels A, B and C accept inputs to the gating circuitry. To enable counting, the gate signal must be open circuit or greater than +2.0 V. To disable counting the signal must be less than +1.0 V or short-to-ground. The gate source must sink 3.0 mA.

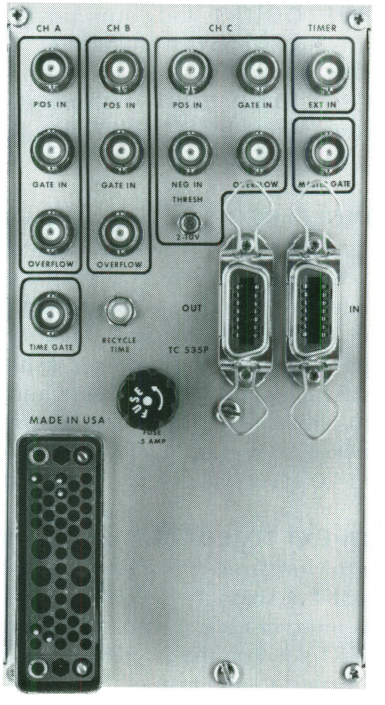
OVERFLOW Rear-panel BNC connectors for Channels A, B and C supply a NIM-standard positive logic, 1 μsec wide signal when the channel exceeds 9,999,999 counts.

TIME GATE Rear-panel BNC used to gate the internal timebase oscillator thus allowing the timer to function as a dead time corrected clock. Any signal >3 V (e.g. an amplifier busy signal) applied to this input will disable the timer. An open circuit or input <1.5 V enables the timer.

TIMER EXT IN Rear-panel BNC connector accepts signals from an external source. Logic 1 is >+2.0 V; Logic 0 is <+1.0 V and the source must sink 3.0 mA.

MASTER GATE Rear-panel BNC accepts signals to simultaneously gate counters A, B, C and the timer. Gating is synchronized with the selected timebase. Normally open, the signal sits at +5 V. To disable or gate off the unit, a short-to-ground or a signal less than +1.0 V is required. The gating source must sink 2.6 mA.

OUT-IN 14-pin Amphenol 57-40140 type connectors on the rear panel carry all master-slave information to counters and/or timers within a system; these connectors also carry the printing information.



ORDERING INFORMATION

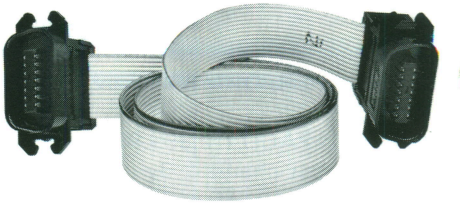
POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 15 mA
−24 V, 0 mA; −12 V, 55 mA
115 VAC, 320 mA

WEIGHT (SHIPPING) 8 lbs. (3.6 kg)
(NET) 5 lbs. (2.3 kg)

DIMENSIONS Standard triple-width NIM module (4.05 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One 2 foot Data Acquisition Cable (Tennelec Model NC-ODA-2) provided with each unit. (See photo)



NC-ODA-2

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

TC 536
Counter and Timer

DESCRIPTION

The **TENNELEC Model TC 536** is **a high performance counter and timer** packaged in a **NIM-standard single width module.** The counter section of the TC 536 will count at a rate of 100 million counts per second **(100 MHz) for the negative input** and 25 million counts per second **(25 MHz) for the positive input.**

The fast negative NIM input pulses can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

A **discriminator is provided for the positive input** and is adjustable over the range of +0.1 to +10V. This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted. A six-decade, seven-segment LED display is featured in the TC 536. Leading zero's are suppressed presenting the data in an easily-read format. A front-panel TEST pushbutton is provided to verify that the LED's are working by displaying an "8" in each decade.

Counting can be externally halted with the GATE input, or manually halted with a COUNT/STOP toggle switch. A front-panel **INTERVAL** LED illuminates whenever the TC 536 is enabled to count, either manually or externally.

The Timer section of the module is designed as an accurate timer suitable for any counting experiment. The time base for the TC 536 is a **crystal controlled oscillator** which allows for less than 0.0005% inaccuracy. The Timer section of the module can be operated in the single cycle or recycle mode. In the recycle mode the reset delay can be adjusted from 0.1 to 10 seconds by using the dwell control. A reset is automatically generated during power-up.

- **Simultaneous counter and timer operation**
- **100 MHz negative and 25 MHz positive input counting capability**
- **Adjustable positive input discriminator**
- **Crystal controlled time base**

SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Six decades (999,999).

COUNTING RATE 100 MHz negative input; 25 MHz positive input.

PULSE PAIR RESOLUTION Negative input 10 nsec; Positive input 40 nsec.

INPUT DISCRIMINATOR Negative input fixed at −250 mV. Positive input variable from +0.1 to +10 volts.

TIMEBASE 10 MHz crystal-controlled oscillator; inaccuracy <0.0005%; temperature instability <0.0002%/°C for 0 to 50 °C.

TIME PRESETS 0.01 to 900,000 sec; 0.01 to 900,000 min.

OPERATING TEMPERATURE 0 to 50°C.

CONTROLS AND INDICATORS

DISPLAY Six decades of seven-segment LED digits.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 536 Counter and Timer

OVERFLOW Front-panel LED illuminates when overflow condition is met.

INTERVAL Front-panel LED illuminates during timing interval.

TEST Front-panel pushbutton tests all seven segments of each LED when pressed, displaying "888888"

RESET Front-panel pushbutton resets display and internal registers to the initial zero condition.

0.01 MIN/0.01 SEC Front-panel toggle switch selects the rate of timing markers.

COUNT/STOP Toggle switch on the front panel selects counting (COUNT) or noncounting (STOP) condition.

DWELL Front-panel single-turn control allows system recycling with an adjustable 0.1 to 10 sec dwell time between counting intervals. An OFF position is provided to inhibit the recycle operation.

DISCRIMINATOR Single-turn potentiometer on the front panel sets the discriminator level for the positive input from +0.1 to +10V.

PRESET Front-panel thumbwheel switches select preset time interval in a N x 10^M format. N selects the most significant digit of the preset as 0 through 9. M selects the power of 10 as 0 through 7.

CONNECTORS

+INPUT Front- and rear-panel BNC connectors accept positive unipolar or bipolar input signals to ±25V. Input amplitude must exceed the adjustable threshold level for 20 nsec. Pulse-pair resolution ≤40 nsec; input impedance 1k ohms; dc-coupled.

- INPUT Front- and rear-panel BNC connectors accept NIM-standard fast negative logic signals, 14 mA into 50 ohms. Minimum width 4 nsec below threshold. Threshold fixed at -250 mV; pulse-pair resolution ≤10 nsec; input impedance 50 ohms; dc-coupled.

GATE BNC connectors on front- and rear-panels accept NIM-standard positive logic signals to control the counter gate. Open circuit or ≥+3 volts to allow counting; ≤+1.5 volts to inhibit counting.

INTERVAL Rear-panel BNC connector which provides a NIM-standard slow positive logic signal that is true only during each present counting interval, ≥+3V during timing interval, ≤+1.5V to inhibit counting.

RESET A rear-panel BNCconnector accepts a NIM-standard logic signal (0.5 μsec wide) or a momentary ground to reset the counter to an initial zero condition. An internal programming pin allows the operator to select which condition is required for external reset. Active low: ≤+1.5V or short to ground for reset, ≥+3V or open circuit for non-reset. Active high: ≥+3V for reset, ≤+1.5V for non-reset.

TIME GATE Rear-panel BNC connector accepts NIM standard slow positive logic signals to gate the internal 10 MHz timebase oscillator off, ≥+3V to gate timebase off, ≤+1.5V to gate timebase on; time resolution = 100 nsec; Z_{in} = 10k ohms to ground. Connection of a system busy signal to the TIME GATE input provides for system dead time correction.

OVERFLOW OUT Rear-panel BNC connector furnishes a NIM-standard positive logic signal 2 μsec wide whenever the counter overflows (999,999). Output impedance ≤10 ohms, dc-coupled.

ORDERING INFORMATION

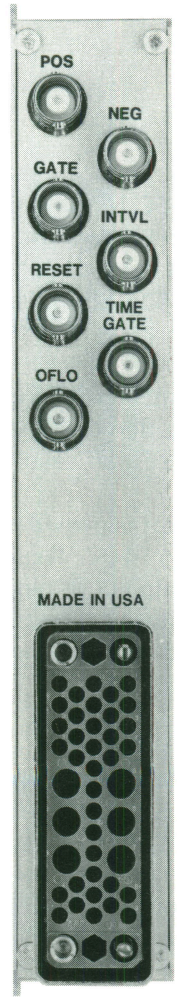
POWER REQUIREMENTS
+24V, 75 mA; +12V, 165 mA
-24V, 0 mA; -12V, 110 mA

WEIGHT (SHIPPING) 5.3 lbs. (2.4 kg)
(NET) 2.3 lbs. (1.1 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714) per TID-20893 (Rev.).

WARRANTY One Year.

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 536 10.0K 782

TENNELEC

TC 541A
Timer

DESCRIPTION

The TENNELEC TC 541A Timer is a single-width NIM module which is designed as an accurate timer for any counting experiment. The timebase for the TC 541A is **crystal controlled** which allows for less than **0.0005% inaccuracy.**

The Timer can be operated in the **single cycle or recycle mode.** Thus, any counter with a gate and reset input can be operated as a recyclable counter-timer.

A front-panel switch selects either 0.01 sec or 0.01 min increments for operation with the internal time base. This allows the TC 541A to have a range from **0.01 sec to 900,000 minutes.** In addition, in the external mode, the Timer will accept 1 to 90,000,000 external timebase input pulses.

Outputs are furnished both during and at the end of the counting interval. The counting interval can be started either manually by the front-panel push-button or electrically by the front- and rear-panel connectors.

In addition to the standard inputs, a **time gate** has been provided. This input accepts NIM-standard positive logic signals to gate the internal time base oscillator off. By connecting a counting system busy signal to the Time Gate, a dead time correction is provided.

- **Crystal controlled time-base for less than 0.0005% inaccuracy**
- **Single cycle or Recycle mode**
- **Time range from 0.01 sec to 900,000 min.**
- **Time gate for dead time corrections**

SPECIFICATIONS

PERFORMANCE

TIMEBASE 10 MHz crystal-controlled oscillator; inaccuracy < 0.0005%; temperature instability < 0.0002%/°C for 0 to 50°C.

TIME PRESETS 0.01 to 900,000 sec; 0.01 to 900,000 min, or 1 to 90,000,000 external timebase input pulses.

EXTERNAL INPUT RATE Any rate up to 1 MHz, using NIM-standard positive logic input signals.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

START Front-panel pushbutton switch which initiates the timing interval. A system reset signal is generated before the synchronous start of the counting interval.

STOP Front-panel pushbutton switch which terminates a counting interval.

0.01 MIN/0.01 SEC Front-panel toggle switch selects the rate of timing markers.

DWELL Front-panel single-turn control allows system recycling with an adjustable 0.1 to 10 sec dwell time between counting intervals. An OFF position is provided to inhibit the recycle operation.

PRESET Front-panel thumbwheel switches select preset time interval in a N x 10^M format. N selects the most significant digit of the preset as 0 through 9. M selects the power of 10 as 0 through 7.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 541A Timer

HIGH/LOW Internal jumper pin selects the polarity of the RESET output. Active HIGH: ⩾ + 3V for reset, ⩽ + 1.5V for non-reset. Active LOW: ⩽ + 1.5V for reset, ⩾ + 3V for non-reset.

INT/EXT Internal jumper pin selects the source of timing pulses. INT position selects internal crystal-controlled timing markers as set by the 0.01 MIN/0.01 SEC control. EXT allows external timing marker references to be counted.

INPUTS

START Front- and rear-panel BNC connectors accept NIM-standard positive logic signals for initiating a timing interval, ⩾ + 3V to generate a system reset signal before the synchronous start of the counting interval, ⩽ 1.5V to not start. Pulse width ⩾ 100 nsec, no max limit; Z_{in} = 10k ohms to ground.

TIME GATE Rear-panel BNC connector accepts NIM-standard positive logic signals to gate the internal 10 MHz timebase oscillator off, ⩾ + 3V to gate timebase off; ⩽ + 1.5V to gate timebase on; time resolution = 100 nsec; Z_{in} = 10k ohms to ground. Connection of a system busy signal to the TIME GATE input provides for system dead time correction.

EXTERNAL Rear-panel BNC connector accepts NIM-standard positive logic signals for external timebase references. Minimum pulse width 500 nsec, pulse pair resolution 1000 nsec; Z_{in} = 10k ohms to ground.

OUTPUTS

INTERVAL Front- and rear-panel BNC connectors which provide a NIM-standard positive logic signal that is true only during each preset counting interval, ⩾ + 3V during timing interval, ⩽ 1.5V to inhibit counting.

STOP Front- and rear-panel BNC connectors provide a 1 μsec wide NIM-standard positive logic pulse at the end of each preset interval; Z_o < 10 ohms dc-coupled.

RESET Rear-panel BNC connector provides a 20 μsec wide NIM-standard positive logic pulse before each timing interval. Reset can be selected active HIGH or active LOW by the internal HIGH/LOW reset select pin.

ORDERING INFORMATION

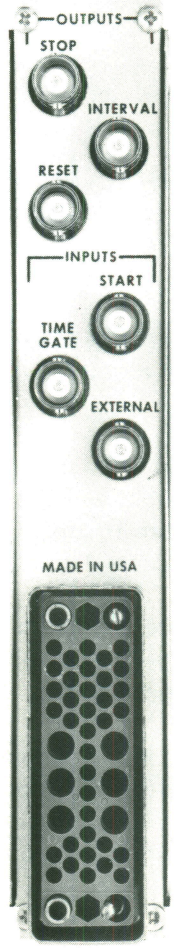
POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 150 mA
−24 V, 0 mA; −12 V, 35 mA

WEIGHT (SHIPPING) 4 lbs. (1.81 kg)
(NET) 1 lb. 12 oz. (0.8 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 541A 10.0K 1082

TENNELEC

TC 546P
Scaler

DESCRIPTION

The TENNELEC TC 546P Scaler is a **six-decade, 20 MHz printing counter** with LED display. The all solid-state display features leading zero suppression. The unit is packaged in a NIM-standard **single-width module.**

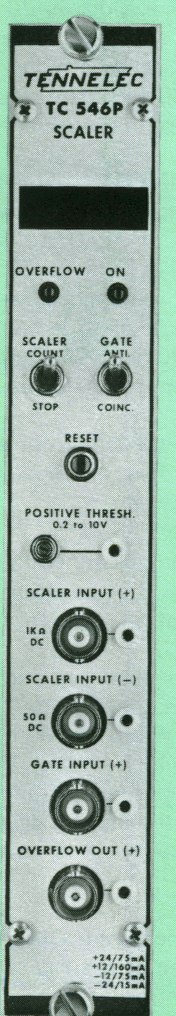
The TC 546P will accept either **positive or negative input pulses** or both simultaneously at a rate of **20 million counts per second** (20 MHz). Bipolar pulses are accepted by either input.

A flexible gating circuit allows either **coincident or anticoincident gating modes,** as selected by a front-panel switch.

LED indicators show when the unit is gated ON and when an **overflow occurs. An overflow output** is provided and is compatible with any of TENNELEC's counters.

Multipin connectors on the rear-panel carry control signals for data acquisition systems and printing outputs. These signals are fully compatible with other TENNELEC and ORTEC data acquisition modules including interfaces for printers and teletypes.

- **Six decade LED display**
- **Printout capability**
- **Single-width NIM module**
- **20 MHz positive and negative inputs**
- **Gated operation**
- **Overflow output**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY 1 X 10^6 - 1 (999,999)

CONTINUOUS COUNTING RATE 20 MHz guaranteed

OPERATING TEMPERATURE RANGE 0° to 50°C

PULSE PAIR RESOLUTION 50 nsec

CONTROLS AND INDICATORS

COUNT DISPLAY Six-decade LED (light emitting diode) display with leading zero suppression.

OVERFLOW INDICATOR Front-panel lamp lights when the TC 546P reaches overflow, representing 1 X 10^6 counts. The overflow indicator may be utilized to expand the count capacity to 2 X 10^6 - 1 or 1,999,999 counts.

ON INDICATOR Front-panel lamp lights when the unit is on.

COUNT/STOP CONTROL Front-panel two-position toggle switch. In the COUNT position, the counter will count if it is not disabled by some other source such as a GATE signal. In the stop position, the counter will not count under any circumstances.

ANTI/COINC GATE CONTROL When this front-panel two-position, toggle switch is in the anticoincident (ANTI) mode, a signal applied at the GATE INPUT connector will inhibit counting. When the GATE switch is in the coincident (COINC) position, a signal applied at the GATE INPUT connector will enable counting.

RESET CONTROL This front-panel pushbutton is used to reset all count decades to zero. The RESET control of a MASTER-set counter affects the counter to which it belongs and any SLAVE-set counters connected to the MASTER. On a

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 546P Scaler

SLAVE-set counter, the RESET button affects only that counter.

POSITIVE THRESHOLD This front-panel 25-turn screwdriver adjustment sets the positive input threshold between +0.2 and +10 V. The threshold set point may be measured with a voltmeter at the monitor jack adjacent to the potentiometer.

CONNECTORS

SCALER INPUT (+) This BNC connector accepts positive pulses between +0.2 and +10 V with an adjustable threshold. Minimum pulse width is 20 nsec, and the minimum spacing between the trailing edge and leading edge of successive pulses is 30 nsec. The input is dc-coupled with a 1k ohm input impedance.

SCALER INPUT (–) This BNC connector accepts negative pulses with a minimum amplitude of –250 mV nominal. Minimum pulse width is 20 nsec, and the minimum spacing between the trailing edge and leading edge of successive pulses is 30 nsec. The input is dc-coupled with an input impedance of 50 ohms.

GATE INPUT This front-panel BNC connector allows external control of the counting circuit.

Note: When no connection is made to this connector, the position of the GATE switch is of no concern.

In the anticoincident (ANTI) mode, positive pulses greater than +1.5 V with a minimum width of 100 nsec at the connector inhibit counting. Pulses less than 0.7 V or open circuit allow counting. In this mode the input is dc-coupled and the input impedance is approximately 1k ohms.

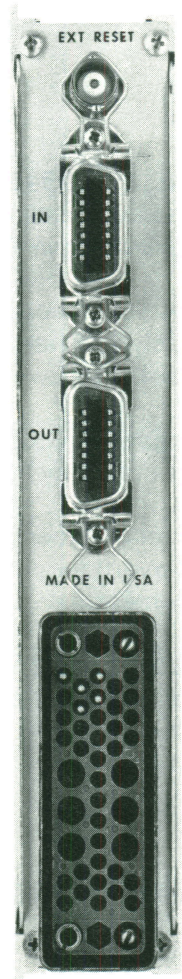
In the coincident (COINC) mode, positive pulses greater than +2 V or open circuit allow counting, pulses less than +1.5 V or short-to-ground inhibit counting. The source must sink 1.0 mA of current. Minimum pulse width is 100 nsec at +2 V. In this mode the input is dc-coupled with an input impedance of 10k ohms.

OVERFLOW OUT When the TC 546P reaches 999,999 counts, the overflow lamp lights and one pulse is generated at this BNC connector. This pulse can be fed to any TENNELEC counter.

The overflow pulse is +5 V in amplitude with a width of 40 microseconds. The output is dc-coupled with an output impedance of 1k ohms.

EXT RESET A positive pulse >+1.5 V with a minimum width of 1 microsecond at this connector will reset the counter to zero counts. The input is dc-coupled with an input impedance of approximately 1k ohms.

IN-OUT These 14-pin Amphenol 57-40140 connectors on the rear-panel of the counter carry all master-slave information to other counters within a system; these connectors also carry the printing information. The upper connector is the IN connector and the lower connector is the OUT.



ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 160 mA
–24 V, 75 mA; –12 V, 14 mA

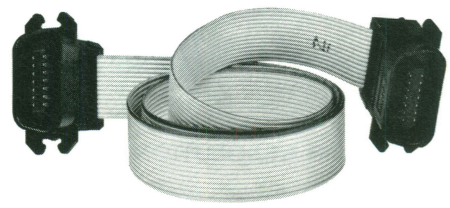
WEIGHT (SHIPPING) 4.5 lbs. (2 kg)
(NET) 2.0 lb. (0.9 kg)

DIMENSIONS NIM-standard single width module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One 2 foot Data Acquisition Cable (Tennelec Model NC-ODA-2) provided with each unit. (See photo)



NC-ODA-2

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 546P 10.0K 882

TENNELEC

TC 547P
Timer/Scaler

DESCRIPTION

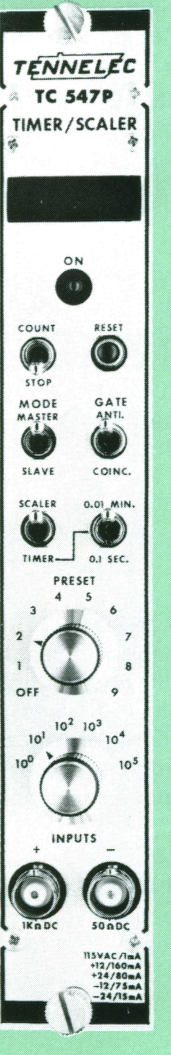
The TENNELEC TC 547P Timer/Scaler can be operated as either a six-decade, **20 MHz printing, presettable scaler or printing presettable timer.** The solid-state LED display features leading zero suppression. The unit is packaged in a NIM-standard **single-width module.**

The TC 547P will accept either **positive or negative input pulses** or both simultaneously. Bipolar pulses are accepted by either input.

A flexible gating circuit allows either **coincident or an anticoincident gating modes. BNC connectors are provided for gate inputs. LED indicator shows when the unit is gated ON.**

Multipin connectors on the rear-panel carry control signals for data acquisition systems and printing outputs. These signals are fully compatible with other TENNELEC and ORTEC data acquisition modules including interfaces for printers and teletypes.

- **Preset Counter or Timer Operation**
- **Six Decade LED Display**
- **Printout Capability**
- **Single-width NIM Module**
- **20 MHz Positive and Negative Inputs**
- **Gated Operation**



SPECIFICATIONS

PERFORMANCE

COUNT CAPACITY Six decades (999,999).

CONTINUOUS COUNTING RATE 20 MHz guaranteed.

OPERATING TEMPERATURE RANGE 0° to 50°C.

TIMEBASE INACCURACY Same as power line frequency, typically 0.035%.

TIMER STARTING ERROR <0.5 μsec.

MAXIMUM PRESET TIME 9×10^4 sec. (25 hours) or 9×10^3 min. (6.25 days).

PULSE PAIR RESOLUTION 50 nsec.

CONTROLS AND INDICATORS

COUNT DISPLAY Six-decade LED (light emitting diode) display with leading zero suppression and decimal display on the timer.

ON INDICATOR Front-panel lamp lights when the unit is enabled.

COUNT-STOP Front-panel two-position toggle switch. In the COUNT position, the scaler will count if it is not disabled by some other source such as a GATE signal. In the stop position, the scaler will not count under any circumstances.

RESET Front-panel pushbutton resets display and internal registers to zero. The RESET control of a MASTER-set scaler resets itself and any SLAVE-set scalers connected to the MASTER. On a SLAVE-set scaler, the RESET button only resets that scaler.

MASTER-SLAVE MODE Front-panel two-position toggle switch determines whether the TC 547P operates in the MASTER or SLAVE mode. Scalers to be controlled by the MASTER-set scaler must be set for slave operation. The SCALER and RESET controls affect the MASTER-set scaler to which they belong as well as the SLAVE-set scalers connected to the MASTER-set scaler. When this control is in the SLAVE position, the SCALER and RESET controls affect only the SLAVE-set scaler to which they belong.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 547P Timer/Scaler

ANTI-COINC GATE Front-panel two-position, toggle switch. When set in the anticoincident (ANTI) mode, a signal applied at the GATE INPUT connector will inhibit counting. When the GATE switch is in the coincident (COINC) position, a signal applied at the GATE INPUT connector will enable counting.

SCALER-TIMER Front-panel two-position toggle switch determines whether the module operates as a scaler or as a timer. In the TIMER mode, the module operates as a TIMER; when the preset time is reached, the TC 547P stops counting. If the TIMER is a MASTER-set timer, all SLAVE scalers connected to it will simultaneously stop and will not start counting again until the timer is reset.

0.01 MIN./0.1 SEC. This front-panel two-position toggle switch selects either a 0.01 min. or 0.1 sec. timebase.

PRESET These two rotary switches establish PRESET COUNT or PRESET TIME. The upper control allows presets of 1 through 9 times the 10^0, 10^1, 10^2, 10^3, 10^4, or 10^5 positions of the lower control. PRESET TIMES available are 1 through 9 times 0.1, 1, 10, 100, 1000 or 10,000 seconds or 0.01, 0.1, 1, 10, 100 or 1000 minutes.

CONNECTORS

SCALER INPUT (+) This BNC connector accepts positive pulses between +1.0 and +10 V with a fixed threshold. Minimum pulse width is 20 nsec, and the minimum spacing between the trailing edge and leading edge of successive pulses in 30 nsec. Input impedance 1 K ohm; dc-coupled.

SCALER INPUT (-) This BNC connector accepts negative pulses with a minimum amplitude of -250 mV. Minimum pulse width is 20 nsec and the minimum spacing between the trailing edge and leading edge of successive pulses is 30 nsec. Input impedance 50 ohms; dc-coupled.

GATE INPUT Rear-panel BNC connector allows external control of the scaler counting circuit.

In the anticoincident (ANTI) mode, positive pulses greater than +1.5 V with a minimum width of 100 nsec at the connector inhibit counting. Pulses less than 0.7 V or open circuit allow counting. Input impedance 1 K ohm; dc-coupled.

In the coincident (COINC) mode, positive pulses greater than +2 V or open circuit allow counting, pulses less than 1.5 V or short-to-ground inhibit counting. Minimum pulse width is 100 nsec at +2 V. Input impedance 10 K ohms; dc-coupled.

IN-OUT Rear-panel 14-pin connectors for use with TENNELEC or ORTEC standard printing systems.

ORDERING INFORMATION

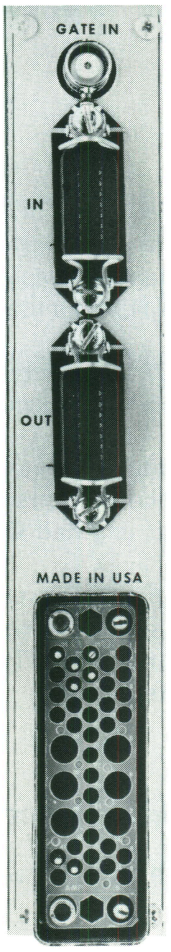
POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 160 mA
-24 V, 75 mA; -12 V, 15 mA
115 VAC, 1 mA

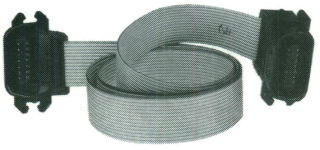
WEIGHT (SHIPPING) 4.5 lbs. (2 kg)
(NET) 2.0 lb. (0.9 kg)

DIMENSIONS Standard single-width module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One 2 foot Data Acquisition Cable (Tennelec Model NC-ODA-2) provided with each unit. (See photo)





NC-ODA-2

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 547P 10.0K 1285

TENNELEC

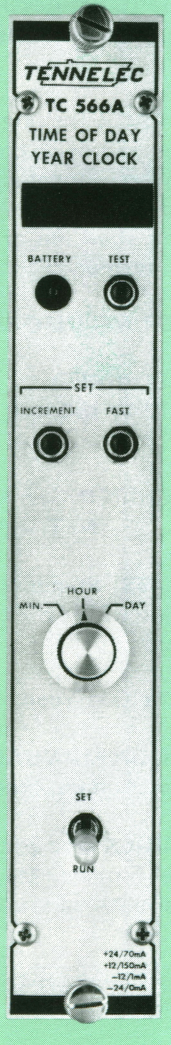
TC 566A
Time of Day/Time of Year Cloc

DESCRIPTION

The TENNELEC TC 566A Time of Day/Time of Year Clock is a **single-width NIM module** which provides Time of Day and Year Information. The module has **printout capability** and can be incorporated into TENNELEC data acquisition systems.

The TC 566A features an internal **battery-back-up** pack to ensure continuous operation even under the condition of AC power failure. A **crystal controlled timebase** provides extremely accurate time keeping over long periods of time and wide temperature ranges. Ease of setup is facilitated by individual days, hours, and minutes positions on the set control.

- **Single-width NIM module**
- **Printout capability**
- **Battery-back-up**
- **Crystal controlled timebase**



SPECIFICATIONS

PERFORMANCE

TEMPERATURE RANGE 0 to 50°C

TIMEBASE ACCURACY
Longterm: ±5 ppm per year
Temperature: 0.04 ppm per °C

BUFFERED OUTPUT The printing output is buffered, thereby eliminating any chance of disrupting normal operation during the printing cycle.

DISPLAY The unit is programmed so that time is displayed for eight seconds and day is displayed for two seconds on an alternating sequence. A continuous display of time of day can be selected via an internal programming pin.

TIME FORMAT The time of day is displayed in hours and minutes in a 24 hour format. A decimal point separating hours and minutes pulses every second.

DAY FORMAT The time of year is displayed in days in a continuous format running from 1 to 365.

CONTROLS

TEST Front-panel push button to test both the Display and the Battery. All segments of the Display LED's and a Battery indicator light-up for visual inspection.

SET-RUN Front-panel locking toggle switch controls the operating mode of the unit.

MIN-HOUR-DAY A front-panel three position switch is provided to set the appropriate display. This switch is operative only when the SET/RUN switch is in the SET position.

SET Front-panel push buttons to set the display

Fast Increments the selected counter (MIN, HOUR, DAY) at a rate of eight digits per second while the push button is depressed. This switch is active only in the SET mode.

Increment Increments the selected display (MIN, HOUR, DAY) one count per depression of the push button. This switch is active only in the SET mode.

INTERNAL JUMPER CONNECTIONS

The unit has provisions inside the module that will allow the days digits to accumulate the following ancillary data:
a) Accumulate hours, 0 to 999
b) Accumulate minutes, 0 to 999
c) Accumulate seconds, 0 to 999
d) Accumulate the number of data acquisitions cycles per counting period.

Provisions are made for resetting or inhibiting the reset function of the days counter.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 566A Time of Day/Time of Year Clock

OUTPUTS

TIMING MARKER OUTPUT A rear-panel BNC connector provides a +5 V, 1 μsec wide pulse at selected intervals; either every second, minute or hour. An internal jumper wire is provided for selection with the instrument set by the factory for an output every second.

IN/OUT Rear-panel Amphenol 14 pin connectors (57-40140) contain all the data and control logic signals for interconnection into the standard Tennelec data acquisition printing loop. NOTE: The output of the TC 566A is buffered so that there is no error in elapsed time during printout.

BATTERY PACK The unit has three size AA batteries to provide backup power to the clock in the event of main power failure. The battery lifetime is essentially equal to the shelf life of the batteries, nominally one year.

ORDERING INFORMATION

POWER REQUIRED
+12 V, 150 mA; +24 V, 70 mA
-12 V, 1 mA; -24 V, 0 mA

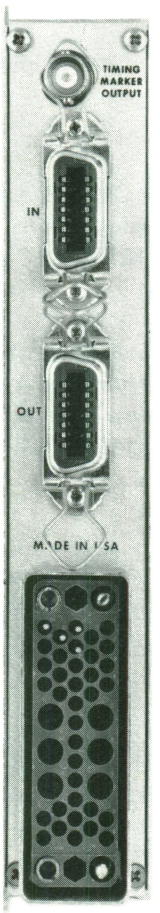
WEIGHT (SHIPPING) 5 lbs. (2.3 kg)
(NET) 2 lbs. (0.9 kg)

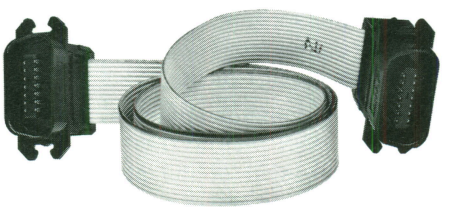
DIMENSIONS Standard Single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One 2 foot Data Acquisition Cable (Tennelec Model NC-ODA-2) and three size AA batteries are included.





NC-ODA-2

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 566A 10.0K 882

TENNELEC

TC 57(
Buffered Printe

DESCRIPTION

The TENNELEC TC 576 Buffered Printer is a triple-width NIM module which automatically **prints the data contained in up to 50 TENNELEC counters, timers or other NIM data modules**. Because the Buffered Printer contains **both the printer and controller**, no additional interfacing is required.

The TC 576 utilizes a **thermal printing** mechanism which provides high reliability and frees the user from periodic replacement of disposable ink pads, ribbons, or pens.

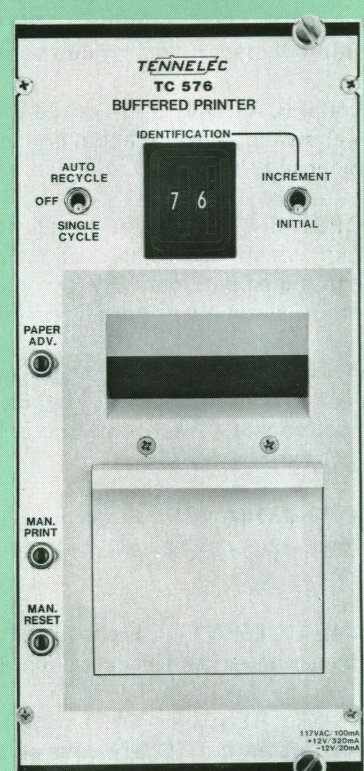
A Buffer function is provided as a standard feature. This feature allows the contents of the printing counters and/or timers to be transferred to a memory within the TC 576. Once this transfer occurs, the counters and/or timers are ready to acccept new data. Thus, the data rate into the TC 576 is not dependent on the printing rate. **The transfer time to the buffer of the TC 576 is approximately 100 microseconds per decade**.

A two-decade thumb-wheel switch allows the user to **manually enter either data or a run identification number**. This number is automatically printed with the other data modules and can automatically increment each time data is transferred to the TC 576.

An alphanumeric character is printed to the left of each data line to identify each device in the print loop (See Fig. 1).

The TC 576 connects directly into the standard TENNELEC or ORTEC printing loop by way of the normal IN and OUT print loop connectors.

- **Buffered for fast data transfer**
- **Prints up to 50 counters and/or timers**
- **Thermal printer**
- **Two digit identification for manual data entry**
- **Line printer and printout controller**



SPECIFICATIONS

PERFORMANCE

BUFFER CAPACITY A buffer storage is provided for up to 192 characters of information; thats more than 27, seven-decade modules.

BUFFER CYCLE TIME Complete data transfer and reset takes less than 800 μs/7 decade counter; 100 μsec per decade plus 100 μsec.

CAPACITY From one to 50 seven-decade, printing modules.

OPERATING TEMPERATURE RANGE 0 to 50°C

```
J......87714
I......43857
H......43857
G........25
F.........4
E......43857
D......43857
C........25
B......43857
A........25
ID NUMBER 65
```

Figure 1

AUTOMATIC CLEAR System is automatically reset when power is applied.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 576 Buffered Printer

PRINT-HEAD LIFETIME > 1 million lines

PRINTER SPEED Typically 2 lines/sec

CONTROLS

AUTO RECYCLE Front-panel toggle switch allows TC 576 and all other modules in the printing loop to reset at the end of the printing cycle and begin a new counting cycle.

OFF Front-panel toggle switch disables printing operation.

SINGLE CYCLE Front-panel toggle switch disables reset. System remains static after one printing cycle and counters/timers hold previous data.

IDENTIFICATION 2-decade thumbwheel switch allows manual data or run number to print.

INCREMENT Front-panel toggle switch which allows the identification number to be automatically incremented by one each time a printing cycle occurs.

INITIAL Front-panel toggle switch allows the identification number to remain constant each time the printing cycle occurs.

PAPER ADVANCE Front-panel push button advances paper through the printer.

MANUAL PRINT Front-panel push button initiates data printout manually.

MANUAL RESET Front-panel push button resets the TC 576 and all other modules in the printing loop.

CONNECTORS

AUTO RECYCLE DELAY IN Rear-panel BNC connector accepts +5 V to inhibit recycle. Active only when mode switch is set at Auto Recycle. Removing +5 V level for a period of 20 μsec or longer causes system reset and starts a new counting cycle.

EXT READOUT INPUT Rear-panel BNC connector accepts NIM positive logic signal to initiate a printout when Readout Mode Switch is either in Single Cycle or Auto Recycle Mode.

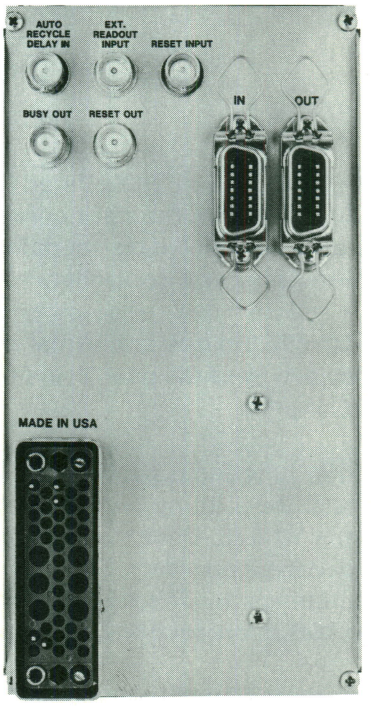
RESET IN Rear-panel BNC connector accepts standard NIM positive logic signals to reset TC 576 and the modules in the printing loop. A signal greater than +3 V causes reset. A signal less than +1.5 V will not cause reset; Z_{in} = 1.5KΩ, dc.

BUSY OUT Rear-panel BNC connector provides a >+3V level while transferring and 0 V when not transferring data into the printer buffer.

RESET OUT Rear-panel BNC connector provides a NIM standard positive logic pulse (+5V, .5 μsec) at the end of a printing cycle.

IN Amphenol Type 57-40140 connector accepts all data and logic signals from the modules of a TENNELEC or ORTEC printing data acquisition system.

OUT Amphenol Type 57-40140 connector provides all logic signals out to a TENNELEC or ORTEC printing data acquisition system.



ORDERING INFORMATION

POWER REQUIRED
+24V, 0mA; +12V, 320mA
-24V, 0mA; -12V, 20mA
117VAC, 100mA

WEIGHT (SHIPPING) 6 lbs (2.72 kg)
(NET) 4 lbs (1.81 kg)

DIMENSIONS Standard triple-width NIM module (4.05 x 8.714 in.) per TID-20893 (Rev.).

WARRANTY One year

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES INCLUDED One system printing loop cable and 3 rolls of printer paper provided with each TC 576.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 576 10.0K 183

TENNELEC

TC 588
Buffered Printer Interface

DESCRIPTION

The TENNELEC TC 588 Buffered Printer Interface interconnects TENNELEC's printing counters and/or timer modules to computers, printers, recorders and calculators over both long and short distances.

The TC 588 connects directly into the standard TENNELEC printing loop by way of rear-panel IN and OUT print loop connectors. The transfer of data from the TC 588 is via standard **RS-232-C or 20 mA current loop communications links.**

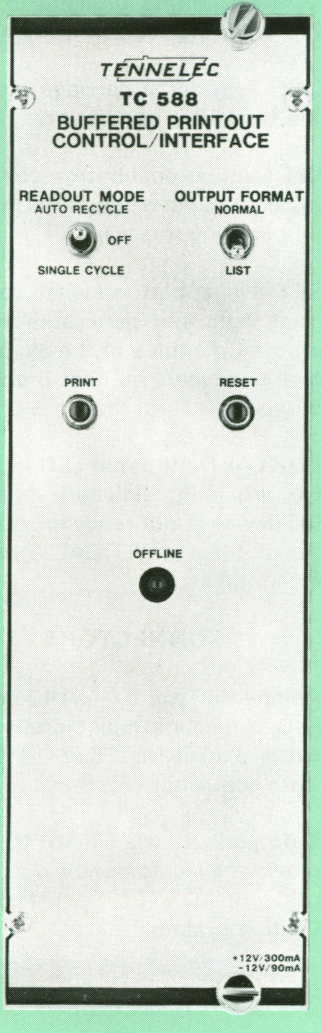
The **Buffer** function as well as a standard interface function is provided. This feature transfers the contents of the printing counter or timer to a memory within the TC 588 module. Once this transfer occurs, the counters and/or timers are ready to accept new data. Thus, the data rate into the TC 588 is not dependent on the output data rate of the interface. The transfer time from the counter or timer is 250 μsec per decade.

A **programming capability** provided by the TC 588 allows the user to program such features as headings, spacing between readouts, line widths, lines per page, fields, alarms, etc. This feature is especially useful when interfacing counters and timers to a computer.

Special commands such as "gate" and "reset" are accessible via both rear-panel BNC connectors and the RS-232-C interface. Control of these functions via keyboard or software allows the user to reset and gate all of his counters and/or timers from one central location.

The TC 588 provides front-panel selection of the output format. The NORMAL mode provides carriage return and line feed only after a full line of data has been printed. The LIST mode provides a carriage return and line feed after each data word.

- **Programmable**
- **Buffered for fast data transfer**
- **Both RS-232-C or 20 mA current loop communications link**
- **Adjustable baud rate**
- **Controllable from keyboard or software**



SPECIFICATIONS

PERFORMANCE

BUFFER CAPACITY A buffer storage is provided for up to 188 characters of information without header programmed; up to 132 characters of header information may be input.

BUFFER CYCLE TIME Complete data transfer and reset is less than 2 msec/7 decade counter; 250 μsec per decade plus 250 μsec.

SCALER CAPACITY From one to 50 printing modules, 6 or more decades each. Full alpha/numeric capability.

BAUD RATE Adjustable in most-often-used steps from 50 to 19.2k Baud. Selected via printed circuit board switches.

CONTROL FUNCTIONS GATE and Reset available via the RS-232-C cable from output devices.

OPERATING TEMPERATURE 0 to 50°C

AUTOMATIC CLEAR System is automatically reset when power is applied.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 588
Buffered Printer Interface

CONTROLS AND INDICATOR

OFF When switch is set at its center position, the data transfer function is disabled.

SINGLE CYCLE Does not generate the automatic reset, thus all system counters and timers remain static after the printout cycle is complete.

AUTO RECYCLE Provides an automatic reset to control circuit and to all the modules in the system so that a new counting interval is initialized.

OUTPUT FORMAT

NORMAL Prints a full line of data before a carriage return and line feed.

LINE Provides a carriage return and line feed after each printed field.

PRINT Manual pushbutton control provides a data transfer command independent of counting interval.

RESET A pushbutton switch resets the internal logic and generates a system reset to all modules in the system. This control also clears all user-programmed functions.

OFFLINE A front-panel LED is provided which, when lit, indicates that an RS-232-C device is not ready for data either because it is in "LOCAL", busy, not powered up, etc.

CONNECTORS

IN Amphenol Type 57-40140 connector accepts all data and logic signals from the modules of a TENNELEC or ORTEC printing data acquisition system.

OUT Amphenol Type 57-40140 connector provides all logic signals out to a TENNELEC or ORTEC printing data acquisition system.

RS-232-C Rear-panel 25-pin connector containing all signals for the EIA standard RS-232-C communications interface.

20 mA Rear-panel 5-pin connector that contains all signals for communicating with devices that use 20 mA data loop; Active Link.

BUSY OUT Rear-panel BNC connector provides a >+3 V level while loading the buffer and 0 V when not loading.

RESET OUT Rear-panel BNC connector provides a NIM-standard positive logic pulse (+5V, .5 μsec) at the end of a printing cycle.

RESET IN Rear-panel BNC connector accepts NIM-standard positive logic signals to reset TC 588 and the modules in the printing loop. A signal greater than +3V causes reset. A signal less than +1.5V will not cause reset; Z_{in} = 1.5k ohms, dc-coupled.

EXT READOUT INPUT Rear-panel BNC connector accepts NIM-standard positive logic signal to initiate a printout when Readout Mode Switch is either in Single Cycle or Auto Recycle Mode.

AUTO RECYCLE DELAY IN Rear-panel BNC connector accepts +5 V to inhibit recycle. Active only when Readout Mode Switch is set at Auto Recycle. Removing +5 V level for a period of 20 μsec or longer causes system reset and starts a new counting cycle.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 300 mA
-24 V, 0 mA; -12 V, 90 mA

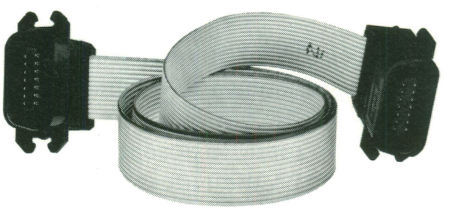
WEIGHT (SHIPPING) 7.9 lbs. (3.6 kg)
(NET) 3.8 lbs. (1.7 kg)

DIMENSIONS Standard double-width NIM module (2.70 in. x 8.714 in.) per TID-20893 (Rev.).

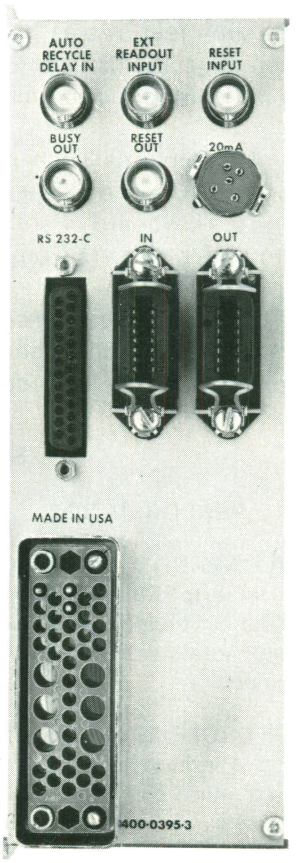
WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument.

ACCESSORIES INCLUDED One printing system control cable (TENNELEC Model NC-ODA-2) and one 20 mA mating connector are provided.



NC-ODA-2



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 588 10.0K 1082

TENNELEC

TC 589
Buffered Interface

DESCRIPTION

The TENNELEC TC 589 Buffered Interface interconnects TENNELEC's printing counters and/or timer modules to computers, printers, recorders and calculators over both long and short distances.

The TC 589 connects directly into the standard TENNELEC or ORTEC printing loop by way of the normal IN and OUT print loop connectors. The transfer of data from the TC 589 is via standard **IEEE Standard 488 or 20 mA current loop communications link.**

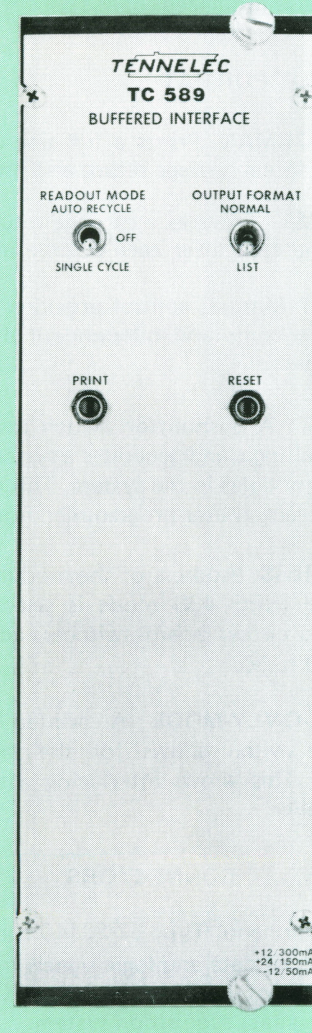
A **Buffer function** as well as a standard interface function is provided. This feature transfers the contents of the printing counter or timer to a memory within the TC 589 module. Once this transfer occurs, the counters and timers are ready to accept new data. Thus, the data rate into the TC 589 is not dependent on the output data rate of the interface. The transfer time from the counter or timer is 250 μsec per decade.

A **programming capability** provided by the TC 589 allows the user to program such features as headings, spacing between readouts, line widths, lines per page, fields, alarms, etc. This feature is especially useful when interfacing counters and timers to a computer or other devices requiring formatted data.

Special commands such as "gate", "reset", and "print" are accessible via both rear panel BNC connectors and the IEEE 488 interface. **Control of these functions via keyboard or software** allows the user to reset and gate all of his counters and/or timers from one central location.

The TC 589 provides front-panel selection of the output format. The NORMAL mode provides carriage return and line feed only after a full line of data has been printed. The LIST mode provides a carriage return and line feed after each data word.

- **Programmable**
- **Buffered for fast data transfer**
- **Both IEEE Standard 488 or 20 mA current loop communication link**
- **Adjustable baud rate**
- **Controllable from keyboard or software**



SPECIFICATIONS

PERFORMANCE

BUFFER CAPACITY A buffer storage is provided for up to 172 characters of information without header programmed.

BUFFER CYCLE TIME Complete data transfer and reset is less than 2 ms/7 decade counter; 250 μsec per decade plus 250 μsec.

CAPACITY From one to 50, seven-decade, printing modules.

BAUD RATE 20 mA link adjustable in most-often-used steps from 50 to 19.2K Baud. Selected via printed circuit board switches.

CONTROL FUNCTIONS GATE, RESET, and PRINT available via the IEEE Standard 488 cable from output devices.

OPERATING TEMPERATURE 0 to 50°C.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 589 Buffered Interface

AUTOMATIC CLEAR System is automatically reset when power is applied.

CONTROLS

OFF When switch is set at its center position, the data transfer function is disabled.

SINGLE CYCLE Does not generate the automatic reset, thus all system counters and timers remain static after the printout cycle is complete.

AUTO RECYCLE Provides an automatic reset to control circuit and to all the modules in the system so that a new counting interval is initialized.

OUTPUT FORMAT

NORMAL Prints a full line of data before a carriage return and line feed.

LIST Provides a carriage return and line feed after each printed module.

PRINT Manual control provides a data transfer command independent of counting interval.

RESET A pushbutton switch resets the internal logic and generates a system reset to all modules in the system. This control also clears all user-programmed functions.

ADDRESS Address of the module when in the IEEE 488 mode is selected via printed circuit board switches; addresses from 0 to 30.

TALK-ONLY-MODE A printed circuit board switch allows for the talk-only mode. This allows interfacing without a controller.

CONNECTORS

IN Amphenol Type 57-20140 connector accepts all data and logic signals from the modules of a TENNELEC or ORTEC printing data acquisition system.

OUT Amphenol Type 57-20140 connector provides all logic signals out to a TENNELEC or ORTEC printing data acquisition system.

IEEE 488 Rear-panel 24-pin connector containing all signals for the IEEE Standard 488 communications interface.

20 mA Rear-panel 5-pin connector that contains all signals for communicating with devices that use 20 mA data loop; Active Link.

BUSY OUT Rear-Panel BNC connector provides a $>+3$ V level while printing and 0 V when not printing.

RESET OUT Rear-panel BNC connector provides a NIM standard positive logic pulse (+5 V, .35 μsec) at the end of a printing cycle.

RESET IN Rear-Panel BNC connector accepts standard NIM positive logic signals to reset TC 589 and the modules in the printing loop. A signal greater than +3 V causes reset. A signal less than +1.5 V will not cause reset; Z_{in} = 1.5K Ω, dc coupled.

EXT READOUT INPUT Rear-Panel BNC connector accepts NIM positive logic signal to initiate a printout when Readout Mode Switch is either in Single Cycle or Auto Recycle Mode.

AUTO RECYCLE DELAY IN Rear-Panel BNC connector accepts +5 V to inhibit recycle. Active only when Readout Mode Switch is set at Auto Recycle. Removing +5 V level for a period of 100 μsec or longer causes system reset and starts a new counting cycle.

ORDERING INFORMATION

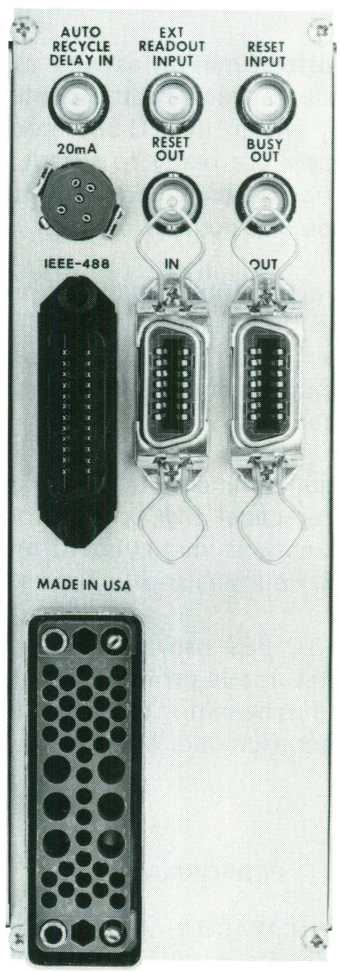
POWER REQUIRED
+12 V, 300 mA; +24 V, 150 mA
−12 V, 50 mA; −24 V, 0 mA

WEIGHT (SHIPPING) 7.9 lbs. (3.6 kg)
(NET) 3.8 lbs. (1.7 kg)

DIMENSIONS Standard double-width NIM module (2.70 in. x 8.714 in.) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument.

ACCESSORIES PROVIDED One print loop cable is provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 589 10.0K 985

TENNELEC

TC 599
Howler

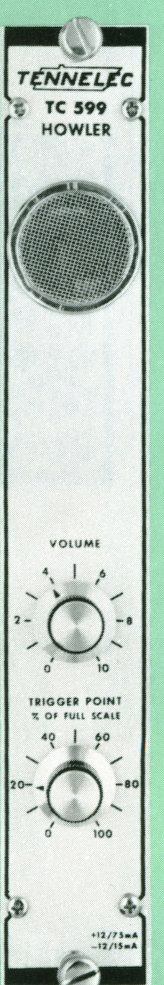
DESCRIPTION

The TENNELEC TC 599 Howler is a **single-width NIM module** that **provides an audible indication of count rate** when connected to **any ratemeter.** The frequency of the **tone varies directly with count rate.**

The TC 599 Howler is especially useful when adjustments effecting the count rate must be made remote from the NIM bin mounted ratemeter. The Howler's varying tone allows you to precisely locate the maximum or minimum count rate and optimize your counting system's performance.

The Howler is an **inexpensive retrofit** for your TENNELEC ratemeters to provide an audible, variable-frequency output. If you should have ratemeters manufactured by other vendors, the Howler is still a useful accessory and eliminates the necessity of purchasing another expensive ratemeter with the built-in audible feature.

- **Useful accessory for any ratemeter**
- **Provides audible indication of count rate**
- **Adjustable volume control**
- **Output frequency range: 4 Hz to 650 Hz**
- **Single-width NIM module**



SPECIFICATIONS

PERFORMANCE

OUTPUT FREQUENCY RANGE
4 Hz to 650 Hz

OPERATING TEMPERATURE RANGE
0° to 50°C

CONTROLS

VOLUME Single-turn front-panel potentiometer

TRIGGER POINT Single-turn front-panel potentiometer, adjustable from 0-100% of full scale input voltage.

INPUT VOLTAGE Three-position rear-panel toggle switch, selects full scale input voltage 100 mV, 1V, 10V.

INPUT POLARITY Two-position rear-panel toggle switch, selects input polarity, positive or negative.

INPUTS

INPUTS Rear-panel BNC connector and rear-panel binding posts.

OUTPUTS

AUDIBLE OUTPUT Variable frequency tone, 4 Hz to 650 Hz, directly variable with count rate.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 0 mA; +12 V, 160 mA
−24 V, 0 mA; −12 V, 20 mA

WEIGHT (SHIPPING) 4 lbs. (1.81 kg)
(NET) 1.9 lbs. (0.85 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID 20893 (Rev.).

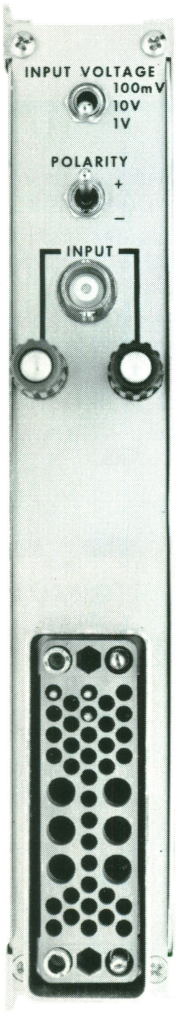
WARRANTY One Year

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 599 Howler



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TC 599 10.0K 1282

TENNELEC

TC 813
Pulser

DESCRIPTION

The **TENNELEC TC 813** Pulser is a single-width NIM module designed to **simulate the output signal from a solid-state or scintillation detector/pre-amplifier combination,** thereby providing a means of testing and calibrating the electronics in a nuclear counting system.

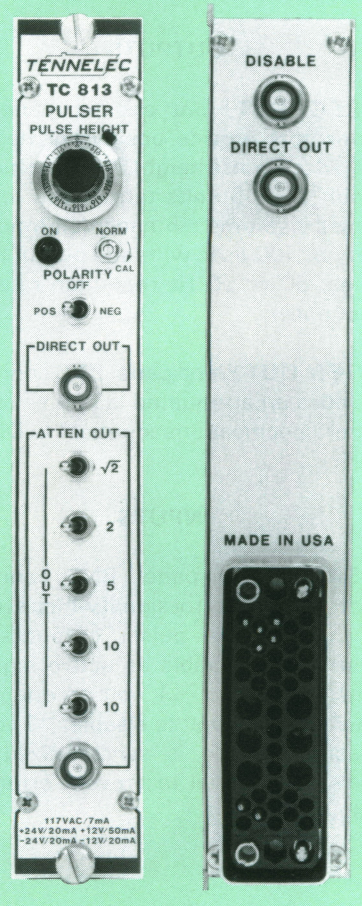
Calibration of nuclear spectroscopy systems and multichannel analyzers, evaluation of system stability, measuring the integral nonlinearity and noise of amplifiers, and selecting delays in coincidence timing systems are **typical applications** for the **TENNELEC TC 813** Pulser.

The TC 813 can be calibrated to read directly in terms of equivalent energy. The continuous pulse height control has a maximum nonlinearity of ±0.25% and the step attenuators are comprised of 1% resistors. A very stable power supply and mercury relay simulate the nuclear pulses, producing pulses with exponential rise times of ≤5 nsec and fall time constants of 130 to 400 μsec. The internal reference voltage is **essentially independent of any modular power supply or ac line voltage changes.**

Five toggle switches place **attenuation of over 1,000:1** in the attenuated output. **Gold-plated switch contacts** ensure reliable electrical contact and eliminates the intermittant continuity problems found in other pulsers. The **direct output precedes the attenuator switches** and provides a means of stable oscilloscope triggering.

The **TC 813** has a **Disable input** that is synchronized with the relay to prevent erroneous outputs. This input may be used to gate the **TC 813** Pulser either on or off by remote or computer control.

- **Simulates detector output signals**
- **Wide range of typical applications**
- **Can be calibrated to read directly in units of energy**
- **Output essentially independent of supply voltage changes**
- **Direct and attenuated outputs**
- **Gold-plated switch contacts**
- **Disable input for gated operation**



Front Rear

SPECIFICATIONS

PERFORMANCE

TEMPERATURE INSTABILITY ≤ ±0.005%/°C, 0 to 50°C.

SUPPLY VOLTAGE INSTABILITY ≤ ±0.001% for a 1% change of the ±24 volt supply voltages.

RIPPLE AND NOISE ≤0.003% of pulse amplitude.

INTEGRAL NONLINEARITY ≤ ±0.25% of full-scale.

RISE TIME (10%-to-90%) ≤5 nsec exponential.

FALL TIME (90%-to-10%) Exponential decay with 130, 200 or 400 μsec time constant, depending on output terminations.

PULSE REPETITION RATE 50 or 60 Hz depending on AC line frequency.

OPERATING TEMPERATURE 0 to 50°C.

CONTROLS AND INDICATORS

PULSE HEIGHT Front-panel 10-turn potentiometer and dial controls output pulse height from 0 to 10 volts open circuit (0 to 5 volts terminated into 50 ohms).

ON Front-panel indicator illuminates when the POLARITY switch is in either the POS or NEG position and the pulser is not disabled through the rear-panel DISABLE input.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 813 Pulser

NORM Front-panel multi-turn potentiometer allows a 2:1 variation of the output amplitude for normalization of the PULSE HEIGHT dial, enabling the user to calibrate the PULSE HEIGHT dial directly in units of energy. Setting the NORM control fully clockwise provides a calibrated 0 to 10 volt output range.

POLARITY Front-panel three-position toggle switch selects positive or negative output polarity. The center OFF position disables the pulser output.

ATTEN Five front-panel two-position toggle switches select attenuation factors of $\sqrt{2}$, 2, 5, 10 and 10.

DISABLE PCB-mounted jumper selects high (>2 volts) or low (<1 volt) mode for rear-panel DISABLE input.

OUTPUTS

DIRECT OUT Front- and rear-panel BNC connectors provide positive or negative tail pulses; pulse height 0 to 10 volts open circuit (0 to 5 volts terminated into 50 ohms); rise time ≤5 nsec; fall time constant of 400 μsec with one output terminated; 50 or 60 Hz repetition rate (line frequency).

ATTEN OUT Front-panel BNC connector provides an attenuated tail pulse output. Other specifications identical to DIRECT OUT.

INPUTS

DISABLE Rear-panel BNC connector accepts a dc control signal which enables or disables the pulser output signal. Internally selectable as active high (>2 volts to disable; <1 volt to enable) or active low (<1 volt to disable; >2 volts to enable). Disable is synchronized with relay drive signal to prevent erroneous outputs.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 20 mA; +12 V, 50 mA
−24 V, 20 mA; −12 V, 20 mA
117 VAC, 7 mA

WEIGHT (SHIPPING) 5 lbs. (2.2 kg)
(NET) 3 lbs. (1.3 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One NC-TERM-50, 50 ohm BNC terminator provided with each **TC 813**.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 813 10.0K 286

TENNELEC

TC 908
Detector Bias Supply

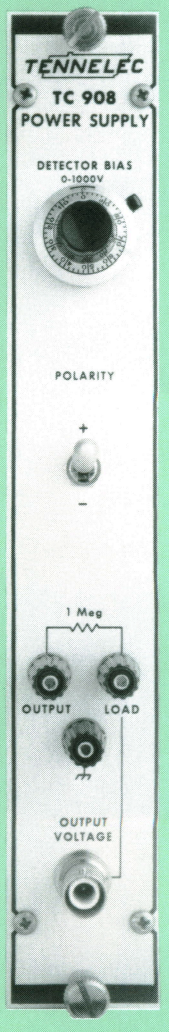
DESCRIPTION

The TC 908 Detector Bias Supply is a single width NIM module designed for solid-state detectors and pulse ionization chambers.

A calibrated ten-turn control provides a **continuously variable output** with a nonlinearity of <0.5%.

The output is short-circuit proof with an impedance of approximately 20 MΩ. Binding posts for **monitoring the detector load current** and the bias voltage are provided on the front panel of the module.

- **Positive or Negative Polarity**
- **Provisions for monitoring detector currents**
- **Continuously variable output**
- **Noise and ripple less than 2mV**



SPECIFICATIONS

PERFORMANCE

NOISE AND RIPPLE <2mV rms

TEMPERATURE INSTABILITY
≤0.02%/°C
0 to 50°C

LINE INSTABILITY ≤±1% for line voltage changes of ±10%.

OUTPUT VOLTAGE 0 to ±1000V

OUTPUT POLARITY Positive or negative, front panel selectable

OUTPUT CURRENT Limited to 50μA
Z_o = 20MΩ

DIAL INACCURACY ≤±1% of full scale

CONTROLS AND INDICATORS

DETECTOR BIAS 10 turn direct-reading potentiometer for bias control

POLARITY Two position locking toggle switch selects the output voltage polarity

CURRENT MONITOR Front panel binding posts for monitoring detector load current and bias voltage

OUTPUTS

OUTPUT VOLTAGE SHV connector on front panel provides short-circuit-proof output; 0 to ±1000V, Z_o = 20 MΩ

ORDERING INFORMATION

POWER REQUIREMENTS
105 to 125V ac @ 40 mA
210 to 250V ac @ 20 mA
50 to 10 Hz
AC power obtained from Bin and Power Supply

WEIGHT
(SHIPPING) 6 lbs (2.7 kg)
(NET) 4 lbs (1.8 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in) per TID-20893 (Rev.)

INSTRUCTION MANUAL One provided with each instrument ordered

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

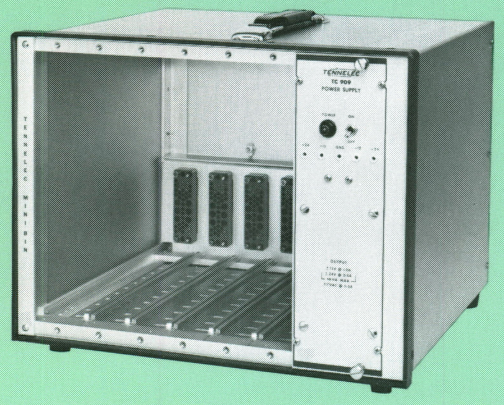
TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 908 10.0K 1085

TENNELEC

MB 1/TC 909
Minibin and Power Supply



- **Test points for monitoring output voltages**
- **Power Supply exceeds NIM recommended specifications**
- **Parallel wiring for lower impedance and less variation of power level**
- **Fully protected against overloads**

DESCRIPTION

TENNELEC's unique Minibin is a portable, light-weight, extremely rugged modular systems bin constructed of extruded aluminum with an anodized finish. Minibin is the answer to problems associated with field usage of NIM instruments, ready transportation of equipment, teaching stations, easy integration of systems and economical use of space. This portable NIM bin features six single-width NIM slots plus space for a dual-width plug-in power supply. A two-inch, tilt-up locking bale for ease in viewing instrument panels is provided. Rubber feet (¾ inch) insure damage-free table-top application and provide means for convection cooling. **Test jacks mounted on the front panel** allow monitoring of all output voltages. Module guides of machined extruded aluminum provide for precision fit of modules and eliminate warping, distortion and/or breakage associated with die-cast, plastic or teflon guides. The TC 909 Power Supply designed expressly for the Minibin provides all the regulated power. It **exceeds all specifications of a standard NIM** Class A power supply for a six-module-wide bin. **Parallel wiring** is used for all voltages thus insuring better isolation between modules and avoiding cumulative voltage drops. Monitor or **test points** for each of the output voltages and ground are conveniently mounted on the front panel.

SPECIFICATIONS

PERFORMANCE

MECHANICAL TOLERANCES in accordance with TID-20893 (Rev.).

PANEL DIMENSIONS 8.75 in. high by 8.10 inches wide.

MODULE CONNECTORS 6 each

INSTALLED WIRING All connectors wired in parallel for +12V, −12V, +24V, −24V, 115V and high quality ground.

TC 909 POWER SUPPLY

INPUT 103V to 130V ac, 47 to 65 Hz or 206V to 257V ac, 47 Hz to 60 Hz.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

MB 1/TC 909
Minibin and Power Supply

DC OUTPUT
+24 V, 0.5 A; +12 V, 1.0 A
-24 V, 0.5 A; -12 V, 1.0 A
Total combined output must not exceed 48VA.

115V OUTPUT Limited to 0.5 A or 57VA.

REGULATION <0.05% for line voltage variations of ±12%; <0.05% for 0 to 100% change in rated load.

INSTABILITY <0.05% for line voltage variations of ±12%; 0.05% of 0 to 100% change in rated load.

TEMPERATURE COEFFICIENT
<0.005%/°C from 0 to 60°C

THERMAL PROTECTION Power Supply is disabled if interior temperature exceeds 95°C.

NOISE AND RIPPLE <3mV peak-to-peak

CIRCUIT PROTECTION Fully protected against overloads via internal protection circuitry. When output current exceeds rated current by 10%, supply is disabled. Power Supply recovers when overload or short is removed.

ORDERING INFORMATION

WEIGHT (SHIPPING) 21 lbs. (9.5 kg)
(NET) 16 lbs. (7.3 kg)

DIMENSIONS 12.25 x 9 x 12 inches (31.12 x 22.9 x 30.5 cm) overall.

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

MB1/TC 909 10.0K 885

TENNELEC

MB 2/TC 910
Midibin and Power Supply

- Test points for monitoring output voltages
- Power Supply exceeds NIM recommended specifications
- Parallel wiring for lower impedance and less variation of power level
- Fully protected against overloads

DESCRIPTION

TENNELEC's unique Midibin is a portable, light-weight, extremely rugged modular systems bin constructed of extruded aluminum with an anodized finish. Midibin is the answer to problems associated with field usage of NIM instruments, ready transportation of equipment, teaching stations, easy integration of systems and economical use of space. This portable NIM bin features ten single-width NIM slots plus space for a dual-width plug-in power supply. A two-inch, tilt-up locking bale for ease in viewing instrument panels is provided. Rubber feet (¾ inch) insure damage-free table-top application and provide means for convection cooling. **Test jacks mounted on the front panel** allow monitoring of all output voltages. Module guides of machined extruded aluminum provide for precision fit of modules and eliminate warping, distortion and/or breakage associated with die-cast, plastic or teflon guides. The TC 910 Power Supply designed expressly for the Midibin provides all the regulated power. It **exceeds all specifications of a standard NIM** Class A power supply for a ten-module-wide bin. **Parallel wiring** is used for all voltages thus insuring better isolation between modules and avoiding cumulative voltage drops. Monitor or **test points** for each of the output voltages and ground are conveniently mounted on the front panel.

SPECIFICATIONS

PERFORMANCE

MECHANICAL TOLERANCES In accordance with TID-20893 (Rev.).

MODULE CONNECTORS 10 each

INSTALLED WIRING All connectors wired in parallel for +12V, −12V, +24V, −24V, 115V and high quality ground.

TC 910 POWER SUPPLY

INPUT 103V to 130V ac, 47 to 65 Hz or 206V to 257V ac, 47 Hz to 60 Hz.

DC OUTPUT

+24 V, 0.75 A; +12 V, 1.25 A
−24 V, 0.75 A; −12 V, 1.25 A

Total combined output must not exceed 72VA.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

MB 2/TC 910
Midibin and Power Supply

115V OUTPUT Limited to 0.5 A or 57VA.

REGULATION <0.05% for line voltage variations of ±12%; <0.05% for 0 to 100% change in rated load.

INSTABILITY <0.3% after 24 hour warm-up at constant line, load and ambient temperature.

TEMPERATURE COEFFICIENT
<0.005%/°C from 0 to 60°C

THERMAL PROTECTION Power Supply is disabled if interior temperature exceeds 95°C.

NOISE AND RIPPLE <3mV peak-to-peak

CIRCUIT PROTECTION Fully protected against overloads via internal protection circuitry. When output current exceeds rated current by 10%, supply is disabled. Power Supply recovers when overload or short is removed.

ORDERING INFORMATION

WEIGHT (SHIPPING) 26 lbs. (11.8 kg)
(NET) 21 lbs. (9.5 kg)

DIMENSIONS 17.6 x 9 x 12 inches (44.7 x 22.9 x 30.5 cm) overall.

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

MB2/TC 910 10.0 885

TENNELEC

TB3/TC 911/TC 911-6
NIM Bin and Power Supply

DESCRIPTION

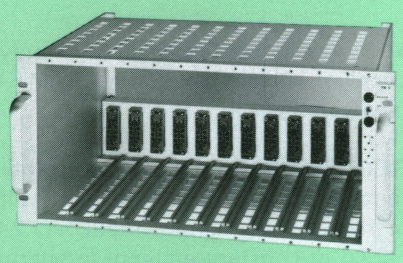
The TB3/TC 911 and TB3/TC 911-6 Tennebins are rackmountable, modular system, powered NIM bins designed to accommodate up to twelve NIM standard single-width modules. The TB3/TC 911 provides ±12 V and ± 24 V to all bin connectors using parallel (bussed) power distribution. The TB3/TC 911-6 provides ±6 V, ±12 V and ±24 V to all bin connectors also using parallel power distribution. Bins and power supplies may be purchased separately, or as integral units.

The TB3 NIM bin is constructed of **extruded aluminum** panels with top and bottom cover plates. Module guides of machined extruded aluminum provide for precision fit of modules and eliminate warping, distortion and/or breakage associated with die-cast plastic or teflon guides. All bin power connectors are provided with ±12 V, ±24 V and ±6 V **parallel wiring** to prevent the cumulative voltage drops associated with "daisy chain" wiring. In addition, the connectors are provided with 115 V ac wiring, a power return ground and a high quality ground for elimination of ground loops.

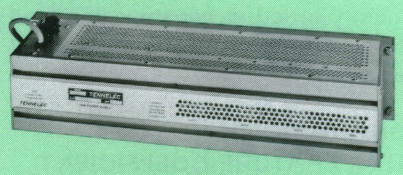
The TC 911 rear mounted power supply provides ±12 V dc at 2 A each, ±24 V dc at 1 A each and 115 V ac at .5 A to the TB3 NIM bin. The TC 911 is designed to **exceed the recommended Type I Class A power supply specifications** as defined in TID-20893 (Rev.). The input power can be either **115 V or 230 V**, furnished through fused input circuits and a 3-conductor NEMA-standard power cord that is included. The TC 911 is constructed of iridited aluminum with an extruded aluminum rear panel which serves as the heat sink for rapid heat dissipation.

The TC 911-6 rear mounted power supply provides ±6 V dc at 10 A (shared), ±12 V dc at 4 A (shared), ±24 V dc at 2 A (shared) and 115 V ac at .5 A to the TB3 NIM bin. The TC 911-6 is designed to **exceed the recommended Type V-H power supply specifications** as defined in TID-20893 (Rev.). The input power can be either **115 V or 230 V**, furnished through fused input circuits and a 3-conductor NEMA-standard power cord.

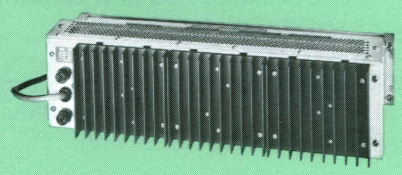
- **Exceeds TID-20893 (Rev.) recommended specifications**
- **Adjustment-free extruded BIN construction**
- **Parallel (bussed) power distribution**
- **115 V or 230 V ac operation**



TB3



TC 911



TC 911-6

SPECIFICATIONS

TB3 NIM Bin

MECHANICAL TOLERANCES In accordance with TID-20893 (Rev.) providing for interchangeability of all standard modules.

MODULE CONNECTORS 12 each as specified by TID-20893 (Rev.).

INSTALLED WIRING All connectors wired in parallel for +12 V, −12 V, +24 V, −24 V, +6 V, −6 V, high quality ground, power-return ground, and 115 V ac, in accordance with TID-20893 (Rev.) pin assignments.

CONTROL PANEL A control panel with on-off switch, power-indicating lamp, and thermal warning lamp provided for mating Power Supply. The thermal warning lamp is illuminated when the operating temperature is just below the design limit. Voltage test points are provided for convenience monitoring of the Power Supply outputs.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TB3/TC 911/TC 911-6
NIM Bin and Power Supply

DIMENSIONS (Standard EIA Rack) 19 in. W x 8.72 in. H x 11.94 in. D (48.26 cm x 22.15 cm x 29.23 cm).

CONSTRUCTION MATERIAL All extruded aluminum construction with machined extruded aluminum module guides.

TC 911 POWER SUPPLY

INPUT 103 V to 129 V ac, 50 to 65 Hz or 210 V to 258 V ac, 50 to 65 Hz.

DC OUTPUT
+24 V, 1 A; +12 V, 2 A
−24 V, 1 A; −12 V, 2 A
Combined maximum output power 96 W at 30°C.

115 V AC OUTPUT Limited only by supply fuses when operating on 115 V ac mains; limited to 0.5 A.

REGULATION <±0.05% over combined range of zero to full load and input voltage of 88% to 110% of rated input over 24 hr. period at constant ambient temperature after a 60 min. warmup.

STABILITY Better than ±0.3% over a 6 month period at constant line load and ambient temperature after a 24 hr. warmup.

OUTPUT VOLTAGE TEMPERATURE COEFFICIENT
<0.005%/°C from 0 to 60°C

NOISE AND RIPPLE <3 mV peak-to-peak, as observed on 50 MHz bandwidth oscilloscope.

VOLTAGE ADJUSTMENT ±0.5% minimum range, resettability ±0.05% of supply voltage (typical ±1 mV).

RECOVERY TIME <100 μsec to return to within ±0.1% of rated voltage for any change in input voltage (within the specified range) and load current from 10% to 100% full load.

CIRCUIT PROTECTION Both input power lines fused; Power Supply is automatically cut off by an internal switch if the temperature exceeds a maximum safe limit; also electronic output current foldback limiting with automatic recovery when demand is removed.

TC 911-6 POWER SUPPLY

INPUT 103 V to 129 V ac, 47 to 65 Hz or 206 V to 258 V ac, 47 to 65 Hz.

DC OUTPUT
+24 V, 1.5 A[1]; +12 V, 3 A[2]; +6 V, 10 A[3]
−24 V, 1.5 A[1]; −12 V, 3 A[2]; −6 V, 10 A[3]

[1]Combined ±24 V currents must not exceed 2 amps.
[2]Combined ±12 V currents must not exceed 4 amps.
[3]Combined ±6 V currents must not exceed 10 amps.
Combined maximum output power 150 W at 30°C.

115 V AC OUTPUT 115 V ac at 0.5 A is available at the ac bin busses. When operated at 230 V ac, 115 V ac is supplied to the ac bin busses.

REGULATION <±0.05% over combined range of zero to full load and input voltage of 88% to 110% of rated input over 24 hr. period at constant ambient temperature after a 60 min. warmup.

STABILITY Better than ±0.3% over a 6 month period at constant line load and ambient temperature after a 24 hr. warmup.

OUTPUT VOLTAGE TEMPERATURE COEFFICIENT
<0.01%/°C from 0 to 50°C; outputs derate 3%/°C for temperatures to 60°C.

NOISE AND RIPPLE <3 mV peak-to-peak, as observed on 50 MHz bandwidth oscilloscope.

VOLTAGE ADJUSTMENT Approximately ±2%, resettability ±0.05% of supply voltage.

RECOVERY TIME <100 μsec to return to within ±0.1% of ±12 V, ±24 V rated voltage and ±1.0% of ±6 V rated voltage for any change in input voltage (within the specified range) and load current from 10% to 100% full load.

CIRCUIT PROTECTION Both input power lines fused; Power Supply is automatically cut off by an internal switch if the temperature exceeds a maximum safe limit; also electronic output current foldback limiting with automatic recovery when demand is removed.

ORDERING INFORMATION

WEIGHT

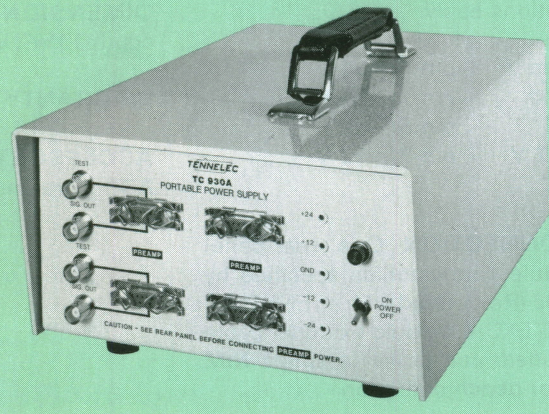
(SHIPPING)	
TB3	16 lbs. (7.3 kg)
TC 911	19 lbs. 12 oz. (9.0 kg)
TC 911-6	27 lbs. (12.3 kg)
(NET)	
TB3	10 lbs. (4.6 kg)
TC 911	17 lbs. 12 oz. (8.1 kg)
TC 911-6	25 lbs. (11.4 kg)

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

TC 930A
Portable Preamp Power Supply



- **Power for 4 preamps**
- **Power for 1 NIM module**
- **Compact and portable**
- **115 or 230 Vac operation**

DESCRIPTION

The TENNELEC Model TC 930A Portable Preamp Power Supply can provide **power for up to four preamplifiers** and **one NIM module. Test points** are provided for monitoring the connector output voltages.

Four preamp power connectors are provided for TENNELEC preamp power configurations (preamp serial numbers 2000 and greater) and are compatible with Canberra and ORTEC preamps. Two connectors allow a TEST input and the preamp output to be routed through the coaxial cables included in a standard TENNELEC preamp power cable. Two connectors provide preamp power only.

Two ADT-1 preamp power adapters are supplied. These adapters convert the preamp power configuration to one compatible with TENNELEC preamps with serial numbers less than 2000.

A standard NIM connector is provided on the rear panel. This connector can be used in conjunction with a TENNELEC NC-EXC-4 module extender cable (not included) to provide power to a single NIM module.

The TC 930A is self-contained in a **compact case with carrying handle** and is available for **either 115 or 230 Vac operation.**

SPECIFICATIONS

PERFORMANCE

REGULATION ≤0.05% rated output variation at full load for ±12% line voltage variations.

±0.25% rated output variation from 0 to 100% full load at constant line voltage.

NOTE: Sense lines are at the connectors. If long power cables are used where the IR voltage drop becomes significant it may be necessary to compensate by increasing the rated output levels.

TEMPERATURE COEFFICIENT
<0.005%/°C from 0 to 50°C

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 930A Portable Preamp Power Supply

THERMAL PROTECTION Power supply is disabled if internal temperature exceeds 95°C.

NOISE AND RIPPLE <3 mV peak-to-peak

CIRCUIT PROTECTION Fully protected against overloads via internal protection circuitry. When output current exceeds rated current by 10%, supply is disabled. Power supply recovers when overload or short is removed.

CONTROL AND INDICATOR

A power ON/OFF switch and indicator light is included.

CONNECTORS

PREAMP Two front-panel Amphenol 17-10090 type connectors for connecting to TENNELEC preamps with serial numbers greater than 2000. In addition to preamp power, these two connectors also provide a means to route the test input and preamp output through a TENNELEC preamp power cable. The following pin-out configuration applies:

pin 1: Power Gnd	pin 6: -24 V
pin 2: Signal Gnd	pin 7: +24 V
pin 3: Preamp out	pin 8: NC
pin 4: +12 V	pin 9: -12 V
pin 5: Test	

TEST One BNC connector associated with pin 5 of the respective preamp power connector. A test pulse signal when applied to this input will be coupled to the preamp input through the standard TENNELEC preamp power cable.

SIG OUT One BNC connector associated with pin 3 of the respective preamp power connector. This connector will provide the preamp output when used with a standard TENNELEC preamp power cable.

PREAMP Two front-panel Amphenol 17-10090 type power connectors used to provide power to TENNELEC (serial numbers greater than 2000), Canberra or ORTEC preamps. The following pin-out configurations apply:

pin 1: Gnd	pin 6: -24 V
pin 2: Gnd	pin 7: +24 V
pin 3: NC	pin 8: NC
pin 4: +12 V	pin 9: -12 V
pin 5: NC	

NIM CONNECTION One rear-panel NIM module connector as specified by TID-20893 (Rev.). Used with a TENNELEC model NC-EXC-4 module extender cable (not included) can power a single NIM module for bench operation.

POWER RATINGS

INPUT Captive 6-ft 3-wire power cord with NEMA standard connector.
103 V to 130 V ac, 47-65 Hz or
206 V to 257 V ac, 47-60 Hz.

DC OUTPUT
+24 V, 0.75 A; +12 V, 1.25 A
-24 V, 0.75 A; -12 V, 1.25 A

Total combined output must not exceed 72 VA.

ORDERING INFORMATION

WEIGHT (SHIPPING) 12 lbs (5.5 kg)
(NET) 10 lbs (4.6 kg)

DIMENSIONS Height 4½", width 8¼", depth 11⅝", with 6-ft power cord.

WARRANTY One year.

ACCESSORY INCLUDED Two model ADT 1 preamp power adapters.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

TENNELEC

TC 948
High Voltage Supply

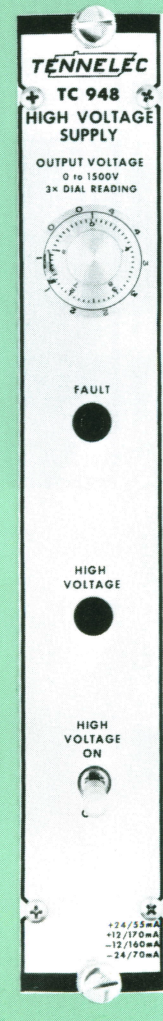
DESCRIPTION

The TENNELEC TC 948 High Voltage Supply is a **single-width NIM module** designed for photomultiplier and electron multiplier tubes. The output is continuously adjustable from **0 to +1500V** with a current capability of **1 mA**. The supply incorporates a precision dial to permit a high accuracy and repeatability of the output voltage level.

Automatic fault protection against overloads, arcing, and short circuits is provided. A front-panel lamp indicates if the protection circuits have been activated.

The unit obtains its power completely from the NIM bin power supply.

- **0 to +1500 V dc at 1 mA**
- **Automatic Fault Protection**
- **Single width NIM Module**



SPECIFICATIONS

PERFORMANCE

OUTPUT VOLTAGE 0 to +1500 volts

OUTPUT CURRENT 0 to 1 mA

RIPPLE AND NOISE $\leqslant$ 10 mV peak-to-peak (typically $\leqslant$ 3 mV).

REGULATION $<$ 0.001%

TEMPERATURE INSTABILITY $<\pm$0.01%/°C, 0 to 50°C

LONG-TERM DRIFT $<$0.01%/hr with constant line and load.

REPEATABILITY 0.05%

CONTROLS

HIGH VOLTAGE ON/OFF Two position locking toggle switch to activate supply.

OUTPUT VOLTAGE Precision 10-turn dial calibrated from 0 to 1.5 kV.

HIGH VOLTAGE INDICATOR Front-panel lamp indicates when high voltage is on.

FAULT INDICATOR Front-panel lamp indicates if the high voltage fault protection circuit has been activated.

OUTPUTS

HV OUT Rear-panel SHV Type Connector furnishes the output voltage.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 55 mA; +12 V, 170 mA
-24 V, 70 mA; -12 V, 165 mA

WEIGHT
(SHIPPING) 5 lbs. 2 oz.(2.3 kg)
(NET) 2 lbs. 2 oz.(0.96 kg)

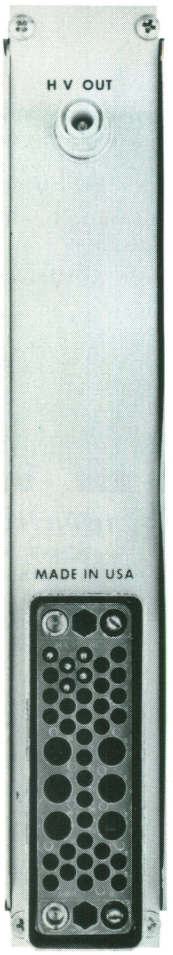
DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provide with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 948 High Voltage Supply



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 948 10.0K 985

TENNELEC

TC 950
Detector Bias Supply

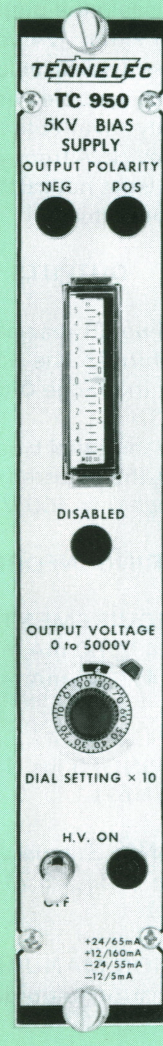
DESCRIPTION

The TENNELEC TC 950 Detector Bias Supply is a single width NIM module which provides a bias voltage of either **positive or negative polarity** for semiconductor detectors or for any type of detector requiring bias currents less than 100 μA; this includes proportional counters and ionization chambers.

Two simultaneous outputs are provided, one for a range of **0 to 5 kV** and the other from **0 to 500 V.** Both output voltages are continuously adjustable by way of a front-panel **5-turn direct-reading potentiometer.** Either polarity is available through both ranges, with the polarity selected by an internal switch and indicated by front-panel lights. A **front-panel meter** monitors the output voltage and provides a visual indication of the polarity and magnitude of the output voltage. A rear-panel disable input is provided for remote shutdown of the output voltage.

The TC 950 Detector Bias Supply receives its necessary operating power through the rear-panel module connector from the TENNELEC TB-3/TC 911 **NIM Bin and Power Supply,** or any other Type I, Class A powered Bin in which it is installed for operation.

- **0- to 5-kV and 0- to 500-V simultaneous outputs**
- **Positive or negative output polarity**
- **5-turn direct-reading voltage control**
- **Front-panel meter**
- **Receives power from NIM Bin Supply**



SPECIFICATIONS

PERFORMANCE

BIAS VOLTAGE OUTPUTS Two output ranges, 0 to 5 kV and 0 to 500 V. Both ranges are available simultaneously.

BIAS POLARITY Either positive or negative for both output ranges, selectable by an internal switch and indicated on the front panel.

BIAS CONTROL 5-turn direct-reading precision potentiometer.

OUTPUT CURRENT 0 to 100 μA.

VOLTAGE STABILITY $\leqslant$0.1%/hr output voltage variation assuming temperature, load and line voltage are constant.

NOISE AND RIPPLE $\leqslant$ 10 mV peak to peak from 5 Hz to 50 MHz.

TEMPERATURE STABILITY $\leqslant$0.02%/°C through 0 to 50°C operating range.

OVERLOAD PROTECTION Short-circuit and overload protection is internally provided with automatic output restoration.

RESETABILITY Output voltage resettable to within 0.2%.

DIAL ACCURACY $\pm$ 1% of full scale.

CONTROLS AND DISPLAYS

OUTPUT VOLTAGE 5-turn direct-reading potentiometer adjusts output levels simultaneously for both output ranges. A front-panel meter indicates the polarity and magnitude of the output voltage.

POLARITY +/− The polarity is selected by an internal switch for both output ranges with two front-panel lamps indicating the polarity selected.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 950 Detector Bias Supply

HIGH VOLTAGE ON/OFF Toggle switch and indicator lamp show when the instrument circuits are turned on to provide an output.

INPUTS

POWER All input power is furnished through the rear-panel module connector from the NIM Bin Power Supply.

DISABLE A rear-panel BNC connector is provided to disable the high voltage output. An internal jumper allows selection of the disable mode. LOW will disable the output of the TC 950 for a pull to ground from either +5 volts or an open circuit. HIGH will disable the output for a pull to ground from either −24 volts or an open circuit. These two disable modes make the TC 950 compatible with virtually any commercially available high voltage shutdown device. A front-panel indicator light gives visual notice that the disable function is operative.

OUTPUTS

0-5000 V Two (2) rear-panel type SHV connectors furnish the adjusted output voltage over the range 0 to 5000 V.

0-500 V A rear-panel type SHV connector furnishes the adjusted output voltage over the range 0 to 500 V.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 210 mA
−24 V, 40 mA; −12 V, 3 mA

WEIGHT
(SHIPPING) 3 lbs. 13 oz. (1.73 kg)
(NET) 1 lb. 6 oz. (0.63 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 950 10.0K 985

TENNELEC

TC 952
High Voltage Power Supply

DESCRIPTION

The TENNELEC TC 952 High Voltage Power Supply with Digital Voltmeter (DVM) is a **highly reliable, well-regulated** high-voltage bias supply designed for use with scintillation detectors, photomultiplier tubes, ionization chambers, and many other devices.

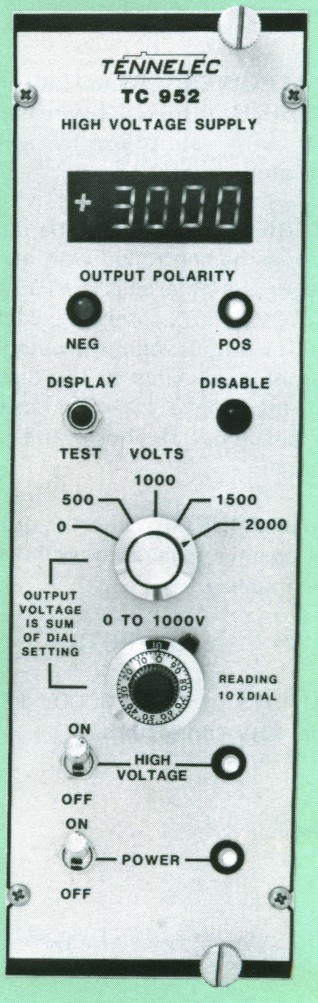
The TC 952 offers **superior stability** and **extremely low ripple;** Noise and ripple on the output is typically **less than 2 mV**, allowing the TC 952 **to be used in the most demanding applications.**

The output voltage is continuously variable from ±1 to ±3000V with **0 to 10 mA** output. **A front-panel** DVM measures the output voltage with **digital accuracy** and also indicates the **output polarity. Four SHV output connectors** allow the TC 952 to power more than one device **simultaneously.**

The TC 952 has **overload, short-circuit,** and **over-voltage protection** making it one of the safest bias supplies available. An internal switch allows the user to select if the high voltage is restored within 7 seconds after an automatic, internally-generated shutdown or remains off until reset.

The input power is obtained from an ac power cord and is switch-selectable for 115 or 220 volts, 45 to 65 Hz. This double-width NIM module **does not receive any power from the NIM bin** and may be used on a bench top if desired.

- **Digital voltmeter readout with flicker-free display**
- **±1.0 to ±3000V, 0 to 10 mA**
- **Output controllable by external input**
- **Remote disable input**
- **Overload, short-circuit, and over-voltage protected**
- **Four SHV outputs**



SPECIFICATIONS

PERFORMANCE

OUTPUT VOLTAGE ±1 to ±3000V dc

OUTPUT CURRENT 0 to 10 mA

OUTPUT POLARITY Positive or negative selected internally.

REGULATION ≤.001% or 3 mV (whichever is greater) variation in output voltage for line or load changes within operating range.

INSTABILITY Long-term drift of output voltage less than 0.001%/hr. and 0.001%/24 hr. period at constant line, load, and temperature.

RIPPLE <10 mV peak to peak dc to 50 MHz (typically <2 mV).

TEMPERATURE COEFFICIENT <30 ppm/°C, 0 to 50°C (typically <10 ppm).

CALIBRATION INACCURACY Output voltage will differ from front panel settings by less than 0.25%.

RESOLUTION 0.5V or better.

RESETTABILITY Resettable to within 1 volt.

OVERLOAD PROTECTION Overload, over-voltage, and short-circuit protection with automatic output restoration.

CONTROLS

POWER Locking type toggle switch for main ac power input.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 952 High Voltage Power Supply

HIGH VOLTAGE Locking type toggle switch for HV output.

OUTPUT VOLTAGE Two front-panel controls set the output voltage when the rear-panel switch is set to INT: 0 to 2000V in 500V steps, and 0 to 1000V with a continuously variable 10-turn potentiometer.

INT/EXT Rear-panel switch selects internal manual operation or external reference input.

POS/NEG PCB mounted switch selects polarity of output for manual operation.

LINE VOLTAGE SELECT Rear-panel switch selects 115V or 220V operation.

INPUTS

INPUT POWER 105V to 129V or 210V to 258V, 45 Hz to 65 Hz, 3-wire captive line cord with standard NEMA Male connector.

EXTERNAL CONTROL The output voltage may be controlled with an external voltage; characteristic is −100V/V ±2% or −300V/V ±2% internal switch selectable. The output voltage developed by the external input adds to the dial setting. Input impedance 100k ohm in the −100 V/V position, 33k ohm in the −300 V/V position.

DISABLE INPUT A short to ground, or a NIM positive logic zero, will disable the power supply.

OUTPUTS

OUTPUTS ±1.0V to ±3000V dc, four rear panel SHV connectors.

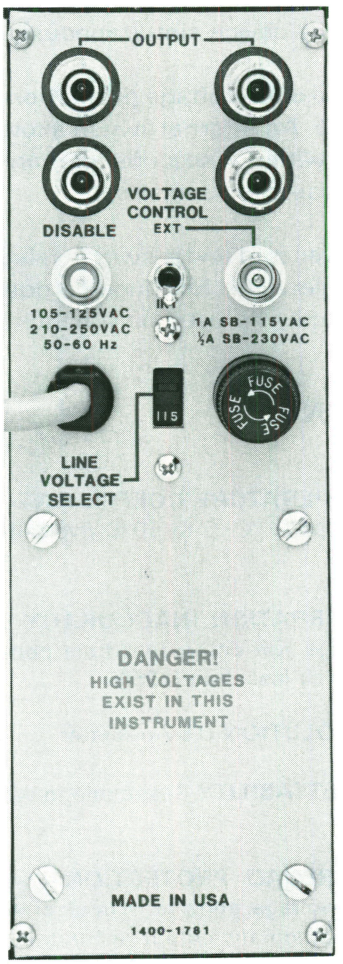
ORDERING INFORMATION

POWER REQUIREMENTS All power obtained from ac power line via captive line cord; current 1.0 A max.

WEIGHT (SHIPPING) 10 lbs. (4.54 kg)
(NET) 8 lbs. (3.64 kg)

DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 952 10.0K 1185

TENNELEC

CP Series High-Purity Coaxial P-Type Germanium Detector Systems

DESCRIPTION

TENNELEC's high-purity Coaxial Germanium detector systems are designed to provide the nuclear spectroscopist with the performance and reliability required for the detection and analysis of gamma radiation in the range of 40 keV to 10 MeV. These detector systems can be **stored indefinitely at room temperature** but are designed to operate at near liquid nitrogen temperature (77° Kelvin).

Each system consists of a high purity semiconductor germanium detector, Uniline vacuum cryostat, liquid-nitrogen dewar, charge-sensitive preamplifier and cable pack.

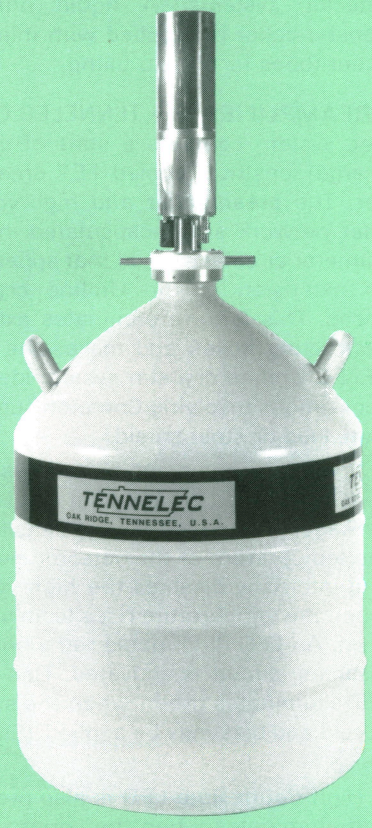
The **TENNELEC** CP series system contains a state-of-the-art **charge sensitive, cooled FET preamplifier**. The preamplifier and high-voltage filter network are encapsulated in a 3" diameter circular shroud that appears as an extension of the **Uniline cryostat** endcap. This feature eliminates external obstructing boxes and makes the **TENNELEC** Uniline cryostat system ideal for applications involving Compton suppression, lead or steel shields.

A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and **internally disables the high voltage** when the temperature rises to an unsafe level. **An LED illuminates red when this disabling circuit is activated**. This same **LED illuminates green when the system is cold** and bias may be applied.

A **High Count Rate LED** is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier.

TENNELEC's semiconductor germanium detectors are produced from **germanium crystals grown by TENNELEC** at our Oak Ridge, Tennessee facility. By producing our own crystals, **TENNELEC** has complete control over the quality, reliability and performance of the entire system.

- **Uniline designed cryostat**
- **Stored indefinitely at room temperature**
- **Unlimited recycles to room temperature**
- **High voltage internally disabled**
- **Charge-sensitive cooled FET preamplifier**
- **High rate LED**
- **"Red" warm, "Green" cold LED**
- **TENNELEC Produced Germanium**



SPECIFICATIONS AND FEATURES

EFFICIENCY This performance specification, most often referred to as the relative photopeak efficiency, is a measure of the photopeak count rate for the detector. It is called the Relative Photopeak Efficiency because it is the photopeak count rate of this detector as compared to a 3" x 3" NaI(Tl) detector's photopeak count rate for the Co-60, 1.332 MeV gamma peak with the source placed 25 cm from the end-cap face of the detector.

This performance specification is measured by the standard method that is described in the IEEE Test Procedures for Germanium Detectors for Ionizing Radiation [ANSI/IEEE 325-1971, (Reaff. 1977)].

RESOLUTION This specification defines the detector systems ability to separate closely-spaced peaks in a spectrum.

TENNELEC warrants the systems full-width-at-half-maximum (FWHM) resolution, including preamplifier contribution, for the 122 keV line of Co-57 and the 1.332 MeV line of Co-60. TENNELEC further warrants the full-width-at-tenth-maximum (FWTM) resolution as a ratio of the FWHM resolution. (See Fig. 1 and Fig. 4)

PEAK-TO-COMPTON RATIO The Peak-to-Compton ratio (P/C) is determined by comparing the average height of the Compton edge of a Co-60 spectrum from 1.040 to 1.096 MeV to the height of

the Co-60, 1.332 MeV peak. This specification describes the detectors ability to identify low-energy peaks in the presence of higher energy peaks. The Compton plateau results from gammas that deposit only a portion of their energies in the sensitive volume of the detector element. (See Fig. 1)

CRYOSTAT TENNELEC's Uniline vacuum cryostat is designed to provide many years of continuous, trouble-free operation. The cryostat is completely sealed and uses cryosorption pumping to maintain the vacuum. No external pumping is required.

The coaxial detector element is a closed-end true-right-circular-cylinder shape and is placed symmetrically in the center of the cryostat endcap with the front face of the crystal ≤5 mm from the front face of the endcap. This spacing increases the geometric efficiency of the detector system when the source is placed very near or on the endcap. (See Fig. 2)

DEWAR A 30 liter liquid-nitrogen dewar is provided with all TENNELEC CP Series detector systems. A liquid nitrogen transfer collar is supplied with inlet and outlet tubes for in-situ filling.

PREAMPLIFIER The TENNELEC CP series system contains a state-of-the-art charge sensitive, cooled FET preamplifier. The preamplifier and high-voltage filter network are encapsulated in a 3" diameter circular shroud that appears as an extension of the Uniline cryostat encap. This feature eliminates external obstructing boxes and makes the TENNELEC Uniline cryostat system ideal for applications involving Compton suppression, lead or steel shield.

A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and internally disables the high voltage when the temperature rises to an unsafe level. An LED illuminates red when this disabling circuit is activated. This same LED illuminates green when the system is cold and bias may be applied. (See Fig. 3)

A High Count Rate LED is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier. (See Fig. 3)

A cable pack is provided with all TENNELEC CP Series Systems. Included are a coaxial high voltage cable (SHV female to SHV female, RG-59A/U, 75 ohm) and a preamplifier power cable. The preamplifier power cable contains three (3) RG-174, 50 ohm coaxial cables. When

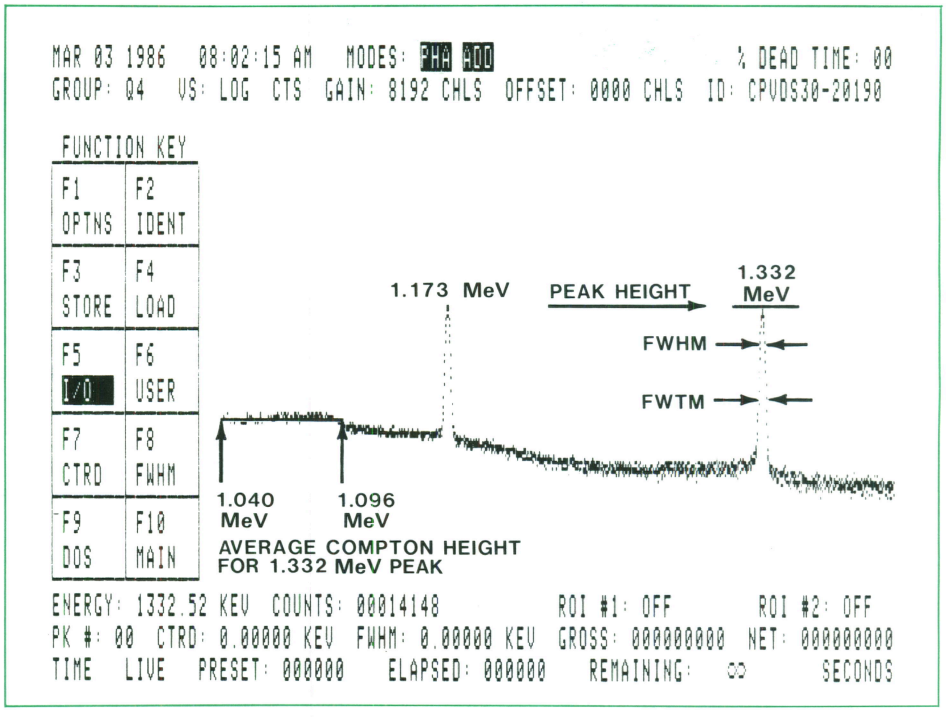


Figure 1 Typical spectral response of TENNELEC CP Series Detector System to Co-60 gamma rays.

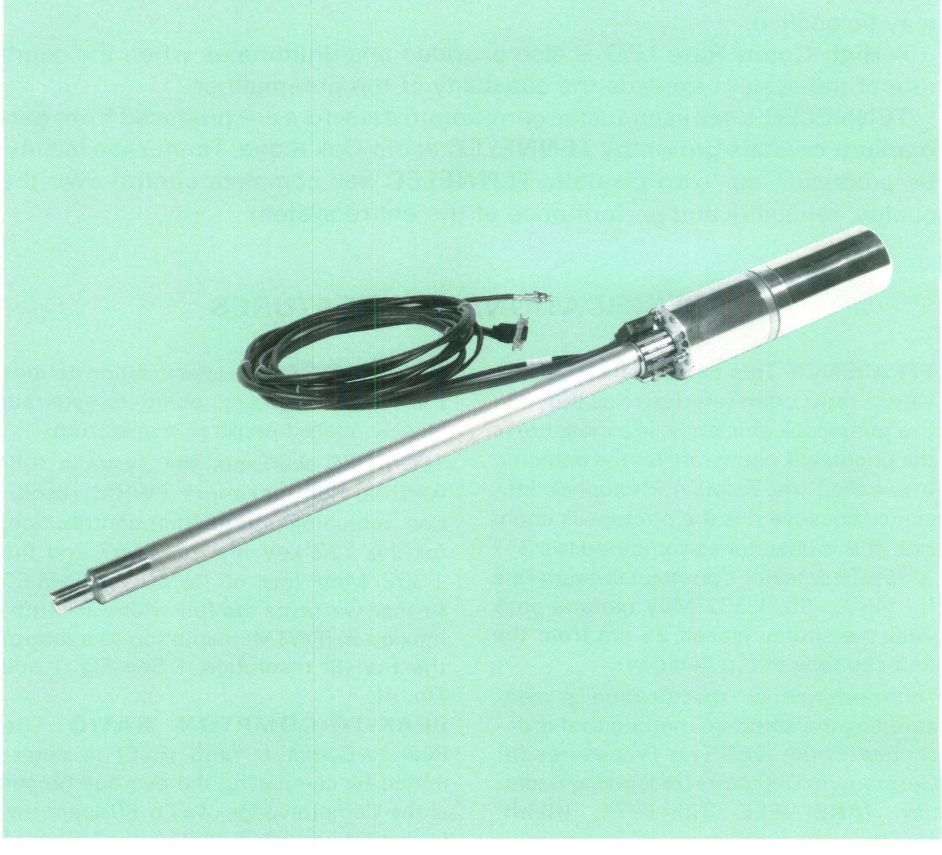


Figure 2 TENNELEC's Vertical Dipstick Uniline Cryostat.

connected to and powered by a TENNELEC amplifier, such as the TC 244, one cable carries the signal from the detector preamplifier to the amplifier; the second is for the Differential input to TENNELEC amplifiers; and the third carries test pulses routed through the amplifier to the preamplifier.

MODEL NUMBER The TENNELEC model number fully describes the detector system in the following format.

AABBBCC-XXYYY/ZZ

AA type of detector
- CP = P-type coax
- CN = N-type coax
- WP = P-type well
- PL = Planar detector

BBB type of cryostat
- VDS = Vertical dipstick
- HDS = Horizontal dipstick
- VDL = Vertical down looking
- HSL = Horizontal side looking

CC dewar volume
- 30 = 30 liter
- 15 = 15 liter
- 75 = 7.5 liter

XX efficiency in percent for coax or diameter in millimeters for planar detectors (refers to AA)

10 = 10%	36 = 36mm
15 = 15%	44 = 44mm
20 = 20%	51 = 51mm

etc.

YYY resolution in keV for coax detectors for Co-60, 1.332 MeV gamma and in eV for planar detectors for Fe-55, 5.9 keV X-ray (refers to AA)
- 185 = 1.85 keV
- 190 = 1.90 keV
- 165 = 165 eV
- 180 = 180 eV

etc.

ZZ optional — for depth of planar detectors in millimeters
- 10 = 10mm
- 13 = 13mm
- 15 = 15mm

EXAMPLE:

C P V D S 3 0 - 2 5 1 8 5

- C P: P-Type Coax
- V D S: Vertical dipstick Cryostat
- 3 0: 30 liter dewar
- 2 5: 25% efficiency
- 1 8 5: 1.85 keV resolution @ 1.332 MeV

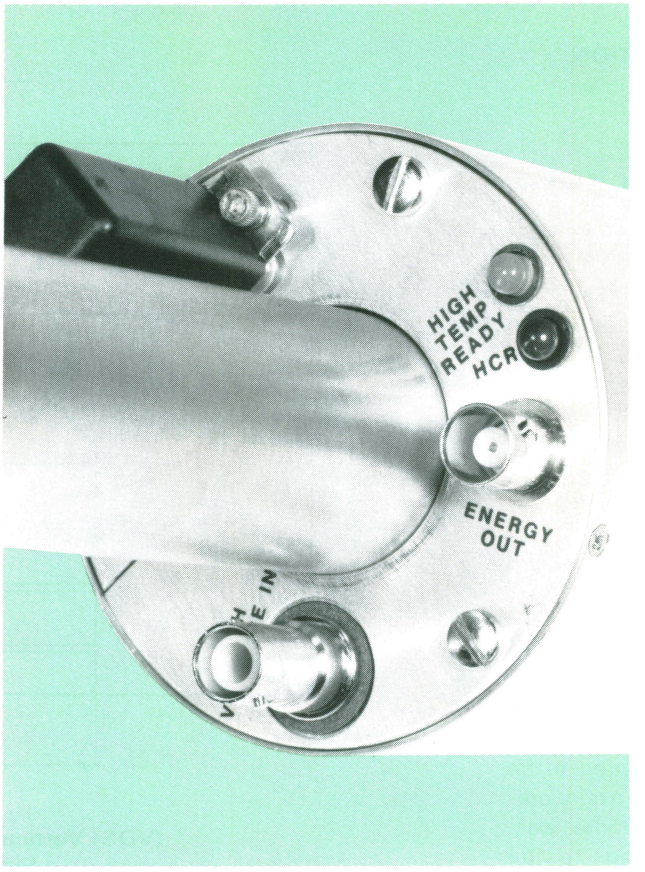


Figure 3 Bottom view of TENNELEC's Uniline Cryostat Preamplifier.

Efficiency %	Resolution 1.332 MeV (keV)	Resolution 122 keV (eV)	P/C Ratio	FWTM/FWHM Ratio
10	1.75	825	41:1	1.90
10	1.85	900	39:1	1.95
10	1.95	1000	37:1	2.00
15	1.80	825	46:1	1.90
15	1.90	900	44:1	1.95
15	2.00	1000	41:1	2.00
20	1.80	850	51:1	1.90
20	1.90	925	48:1	1.95
20	2.00	1100	46:1	2.00
25	1.85	850	55:1	1.90
25	1.95	925	52:1	1.95
25	2.10	1100	48:1	2.00
30	1.85	875	58:1	1.90
30	1.95	950	56:1	1.95
30	2.10	1200	52:1	2.00

Figure 4 Performance Specifications for CP Series Detector Systems.

ORDERING INFORMATION

SYSTEM WEIGHTS

VERTICAL DIPSTICK SYSTEM
(Net) 36 lbs. (16.4 kg)
(With LN_2) 89 lbs. (40.5 kg)
(Shipping) 53 lbs. (24.1 kg)

HORIZONTAL DIPSTICK SYSTEM
(Net) 41 lbs. (18.6 kg)
(With LN_2) 94 lbs. (42.7 kg)
(Shipping) 60 lbs. (27.3 kg)

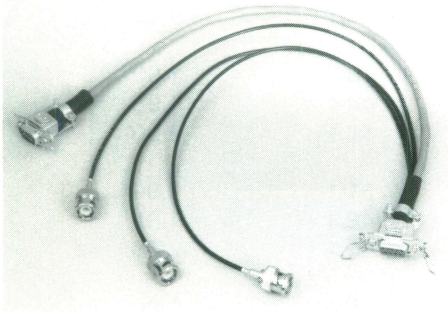
SHIPPING CARTON SIZES

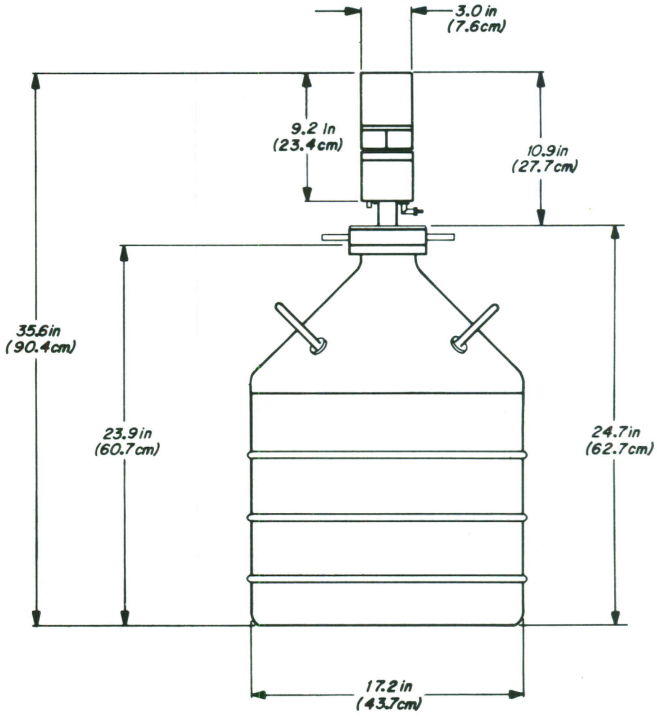
(includes wooden pallet)
VERTICAL DIPSTICK SYSTEM
24" x 24" x 52"
61 cm x 61 cm x 132 cm

HORIZONTAL DIPSTICK SYSTEM
24" x 30" x 52"
61 cm x 76 cm x 132 cm

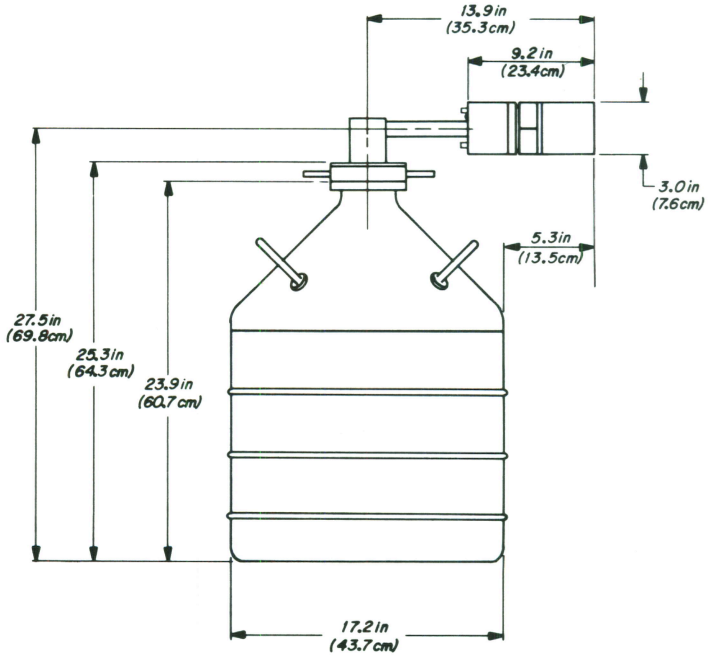
WARRANTY TENNELEC CP Series Detector Systems are warranted to be free from defects in material and workmanship, to meet or exceed the warranted specifications and to be recyclable from liquid nitrogen to room temperature an indefinite number of times for a period of one (1) year.

ACCESSORIES AVAILABLE An ADT-2 Preamp power cable adapter is available for systems that are interfaced to amplifiers other than TENNELEC. This adapter brings the Signal, Differential and Test lines from the TENNELEC power cable out to male BNC connectors.





(VDS) Vertical Dipstick System Side View



(HDS) Horizontal Dipstick System Side View

TENNELEC INC.
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TENNELEC

NaI(Tl)
Gamma and X-Ray Scintillation Detectors

- **Gamma and X-ray Spectrometry**
- **Solid and well-type**
- **Integral assemblies**
- **Hermetically sealed**
- **Mumetal shield**

DESCRIPTION

TENNELEC offers superior performing thallium-activated, sodium iodide crystal detectors for **gamma and X-ray spectrometry. Solid and well-type** right circular cylinder integral assemblies are available to provide the optimum efficiency and resolution required by the spectroscopist.

TENNELEC's gamma detectors are **integral assemblies** which contain selected crystals coupled to the photomultiplier tube face. The entire assembly is **hermetically sealed** in a moisture-proof, light-tight case with a 20 mil aluminum entrance window and is protected against external magnetic fields by means of a **mumetal shield.** This shield extends over the photomultiplier tube photocathode. The photomultiplier tube is selected for optimum spectral response, intrinsic resolution, linearity of response and gain drift.

TENNELEC's low energy X-ray detectors feature an ultra-thin 5 mil beryllium entrance window.

The detector assemblies listed are standardly supplied by TENNELEC. Other sizes and types are available on special request.

SPECIFICATIONS

Solid Right Circular Cylinder, Integral Assemblies

Model Number	Crystal Size (Diameter x Height)	Guaranteed Res (For Cs-137)	PMT Size
TD 25 S 25	1" x 1"	8.5%	2", 14 pin
TD 38 S 38	1.5" x 1.5"	8.5%	2", 14 pin
TD 51 S 51	2" x 2"	8.5%	2", 14 pin
TD 76 S 76	3" x 3"	7.5%	3", 14 pin

End-Well Right Circular Cylinder, Integral Assemblies

Model Number	Crystal Size (Diameter x Height)	Well Size (Diameter x Depth)	Guaranteed Res (For Cs-137)	PMT Size
TD 51 SP 51	2" x 2"	1" x 1.546"	9.0%	2", 14 pin
TD 76 SP 76	3" x 3"	1" x 2.0"	9.0%	3", 14 pin

Thin Window X-Ray, Integral Assemblies
(Supplied with 0.005" Be radiation entrance window)

Model Number	Crystal Size (Diameter x Thickness)	Guaranteed Res (For Fe-55)	PMT Size
TD 25 SX 1	1" x 0.040"	55%	1.5", 12 pin
TD 38 SX 2	1.5" x 0.080"	55%	1.5", 12 pin

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

NaI(Tl)
Gamma and X-Ray Scintillation Detectors

ORDERING INFORMATION

WEIGHT (SHIPPING) 6 lbs. (2.72 kg)
(NET) 3 lbs. (1.36 kg)

WARRANTY One year

INSTRUCTION MANUAL One provided with each detector ordered.

ACCESSORIES TENNELEC manufactures a full line of NIM and associated electronics as well as low background lead shields suitable for scintillation detectors and other types of counting and spectroscopy systems.

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TENNELEC

CAM 500 SERIES
Alpha Detectors

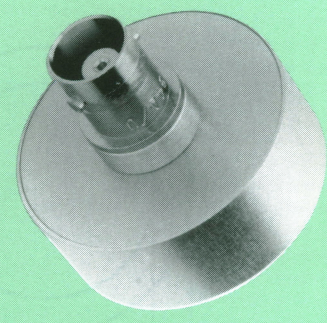
DESCRIPTION

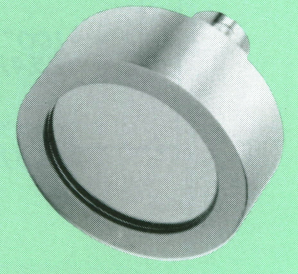
TENNELEC's CAM 500 Series Alpha Detectors are specifically **designed** and **produced to operate in commercially available continuous air monitors,** being used to monitor the presence and concentration of alpha emitting radionuclides.

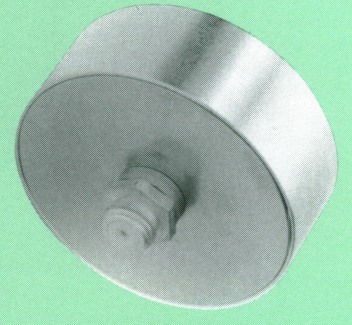
The CAM 500 Series detectors are **500 mm² nominal active area** and **available in two models based on the mounting configuration.** The CAM 500B has a **rear-mounted female BNC** connector and the CAM 500M has a **rear-mounted female microdot** connector. See Figure 1 for dimensions. These dimensions allow the CAM 500 Series detectors to be immediately placed into service without any modifications necessary to the air monitoring system.

All CAM 500 Series detectors are **resistant to ambient light** and **cleanable,** two features that can dramatically extend their usable lifetime over other types of alpha detectors.

- **Designed for continuous air monitors**
- **500 mm² active area**
- **Two mount configurations**
- **Light resistant**
- **Cleanable**







SPECIFICATIONS

ACTIVE AREA 500 mm² nominal

DEPLETION DEPTH Sufficient for 10 MeV alphas with +24 volts bias

OPERATING VOLTAGE +24 volts (+50 volts available on special order)

ENTRANCE WINDOW Aluminum, ≤0.3 microns (Silicon equivalent) thick

RESOLUTION ≤55 keV FWHM (full width at half maximum) for Am-241, 5.486 MeV alphas

NOISE ≤50 keV FWHM

LEAKAGE CURRENT ≤3.0 microamperes at +24 volts

MOUNT Irridited aluminum can with rear-mounted female BNC or 93 ohm female microdot connector

NOTE: All TENNELEC specifications and definitions of terms comply with the latest revision of IEEE/ANSI 300 and IEC 333.

ORDERING INFORMATION

WEIGHT (SHIPPING) 1.0 lbs. (0.45 kg)
(NET) 0.2 lbs. (0.09 kg)

INSTRUCTION MANUAL One provided with each order

WARRANTY One year. A warranty statement is provided with each order.

TENNELEC INC.
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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

CAM 500 Series Alpha Detectors

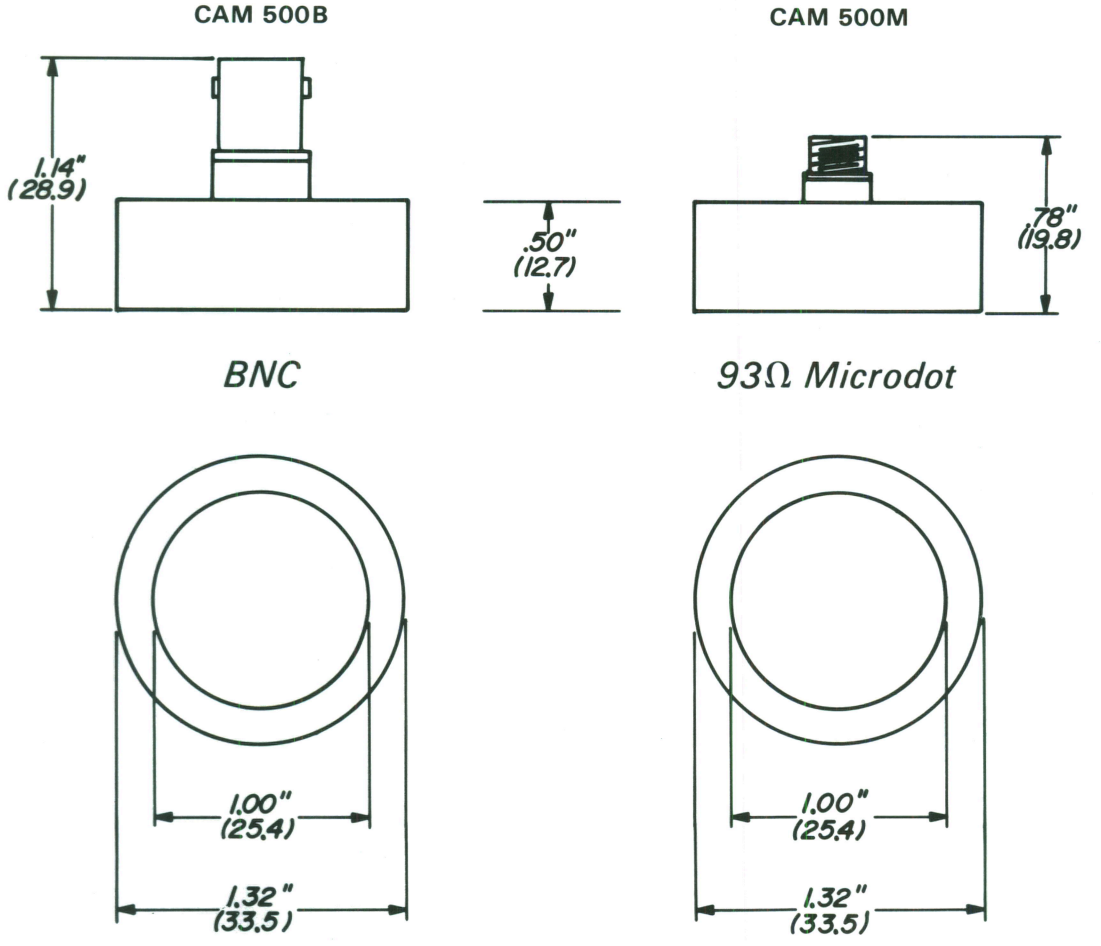

FIGURE 1. Mount dimensions (mm)

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CAM 500 Series 10.0K 984

TENNELEC

HE 500 SERIES
Harmful Environment Alpha Detector

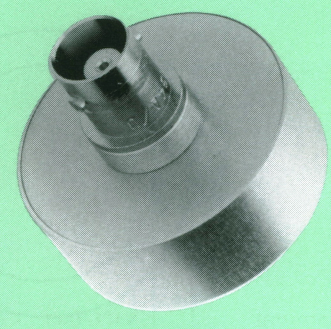
DESCRIPTION

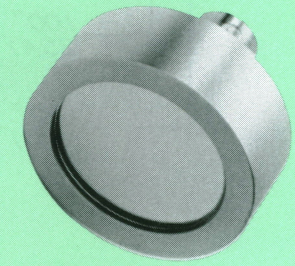
TENNELEC's HE 500 Series Harmful Environment Alpha Detectors are specifically **designed** and **produced to operate in commercially available continuous air monitors** under harmful corrosive gas conditions.

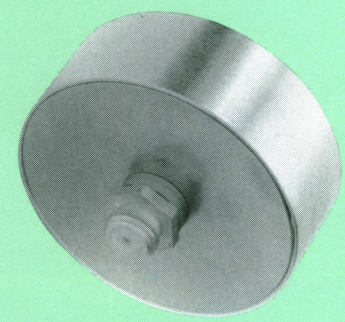
The HE 500 Series detectors are **500 mm² nominal active area** and **available in two models based on the mounting configuration.** The HE 500B has a **rear-mounted female BNC** connector and the HE 500M has a **rear-mounted female microdot** connector. See figure 1 for dimensions.

All HE 500 Series detectors are **cleanable** and have a **corrosion-resistant polymer coating** over the front gold electrode. This coating protects the gold-formed junction of the detector from harmful gases such as hydrofluoric acid and dramatically extends the useable lifetime of this detector under conditions that would far more rapidly destroy any other type.

- **Corrosion resistant coating**
- **Designed for continuous air monitors**
- **500 mm² active area**
- **Two mount configurations**
- **Cleanable**







SPECIFICATIONS

ACTIVE AREA 500 mm² nominal

DEPLETION DEPTH Sufficient for 10 MeV alphas with +24 volts bias

OPERATING VOLTAGE +24 volts (+50 volts available on special order)

ENTRANCE WINDOW Gold and polycarbon, ≤1.0 micron (Silicon equivalent) thick

RESOLUTION ≤55 keV full width at half maximum (FWHM) for Am-241, 5.486 MeV alphas

NOISE ≤50 keV FWHM

LEAKAGE CURRENT ≤3.0 microamperes at +24 volts

MOUNT Rugged metalized can with rear-mounted female BNC or 93 ohm female microdot connector

NOTE: All TENNELEC specifications and definitions of terms comply with the latest revision of IEEE/ANSI 300 and IEC 333.

ORDERING INFORMATION

WEIGHT (SHIPPING) 1.0 lbs. (0.45 kg)
(NET) 0.2 lbs. (0.09 kg)

INSTRUCTION MANUAL One provided with each order

WARRANTY One year. A warranty statement is provided with each order.

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

HE 500 Series
Harmful Environment Alpha Detector

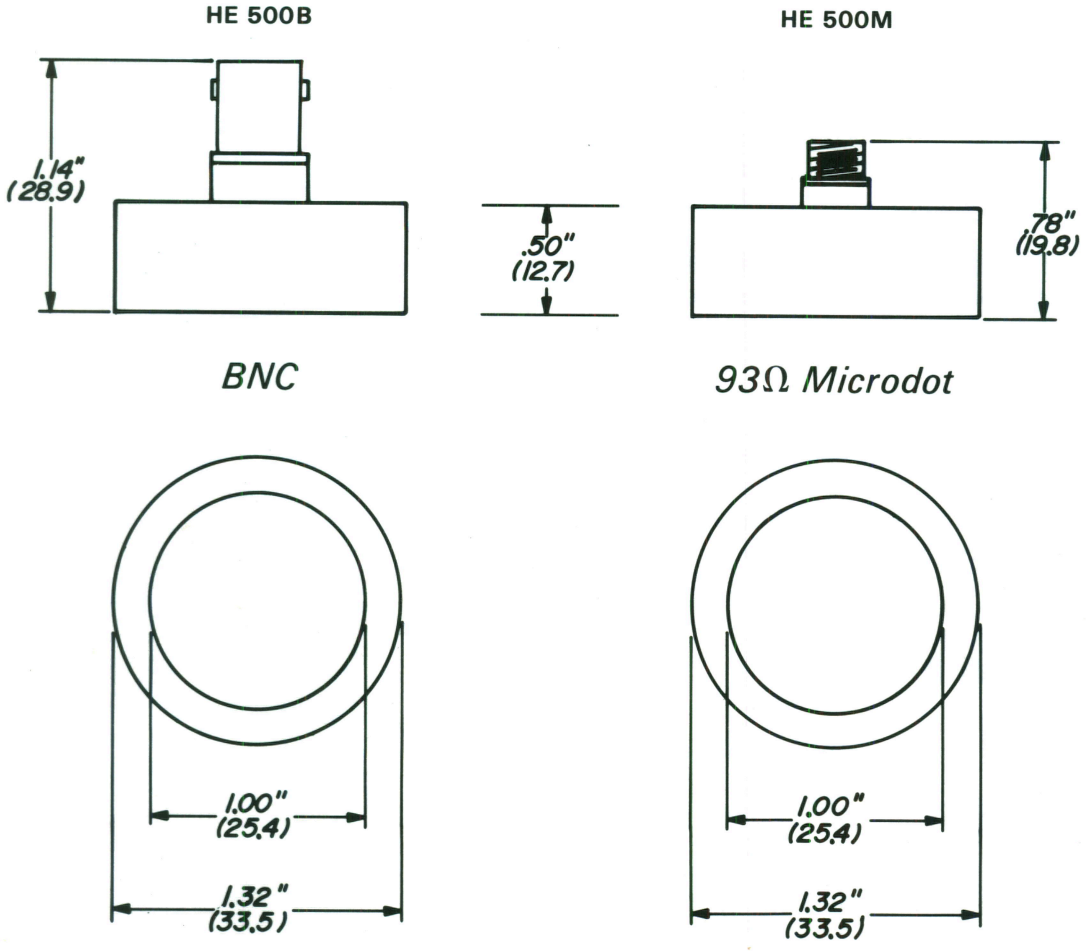

FIGURE 1. Mount dimensions (mm)

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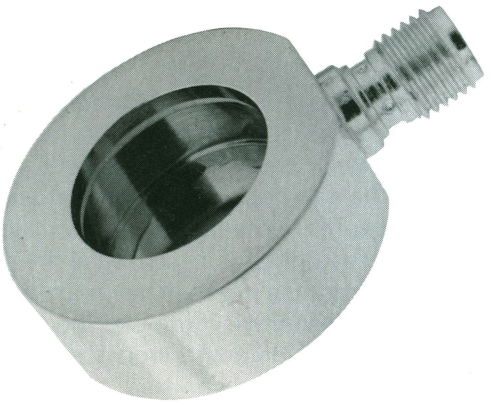
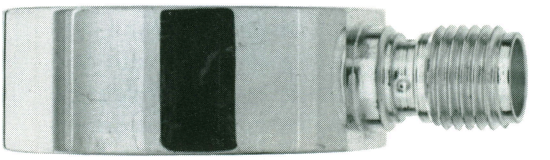
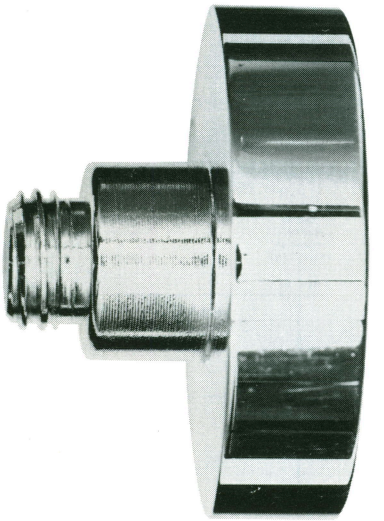
TENNELEC

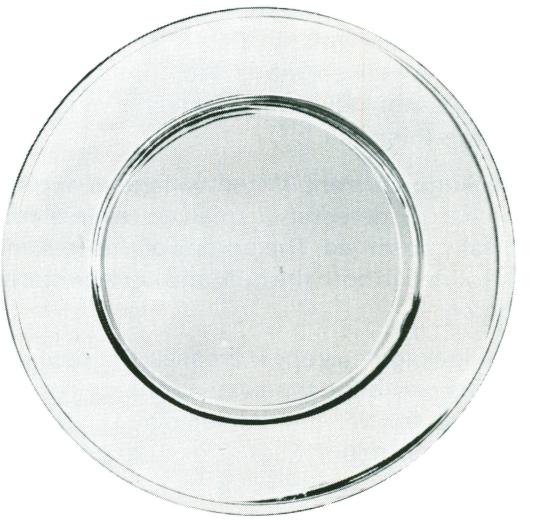
Selection Guide

Silicon Charged Particle Detectors









TENNELEC **Silicon Charged Particle Detectors** are available in several active areas from 25 mm^2 to 2000 mm^2, sensitive depths from 40 microns to greater than 1000 microns and in extremely compact, Slimline™ housings to provide the research and industrial spectroscopist with the correct detector for nearly any application.

TENNELEC's comprehensive line of detectors consists of eight (8) series.

- **PD Series** — Partially Depleted
- **PP Series** — Premium Partially Depleted
- **CE Series** — Cleanable Front Electrode
- **TD Series** — Transmission Detector
- **TP Series** — Transmission Planar
- **HI Series** — Heavy Ion
- **HE Series** — Harmful Environment
- **CAM Series** — Continuous Air Monitor

Introduction

TENNELEC Silicon Charged Particle Detectors are surface barrier detectors made of high quality, single crystal silicon utilizing state-of-the-art technology.

Surface barrier detectors for charged particle spectroscopy have wide application in physics and nuclear chemistry. They can be used to detect and analyze charged particles over a broad range of energies with essentially 100% efficiency for their active volume.

A detector's active volume is created by an electric field applied across the detector's contacts. This electric field sweeps the region between the detector contacts free of charge carriers. Incoming charged particles enter this charge-free region through a thin, insensitive window of gold or aluminum. Through electromagnetic and electrostatic (Coulomb) interaction, the charged particle's energy is transferred to the detector, creating electron-hole pairs. These electron-hole pairs are then swept clear of the depleted, sensitive region and collected on the oppositely-charged electrodes (detector contacts). The integrated charge collected is proportional to the energy lost by the incident charged particle.

Operational Characteristics

Area The active area of the detector selected for any application is very important as it affects both the counting efficiency and energy resolution of the system. These two parameters are in conflict with one another. A larger active area detector will always be more efficient, however, a smaller active area detector will have a lower capacitance and thus provide better energy resolution.

Selecting the correct detector area for an application often requires a compromise between counting efficiency and energy resolution.

Collimation TENNELEC incorporates a precisely machined collimator with its detector so that the entrance window active area is accurately defined. TENNELEC does not rely on the detector mounting epoxy to define this area.

Reverse Leakage Current When voltage is applied to a surface barrier detector, a small dc reverse current is normally observed. The origins of this leakage current are related to both the bulk and surface states of the detector.

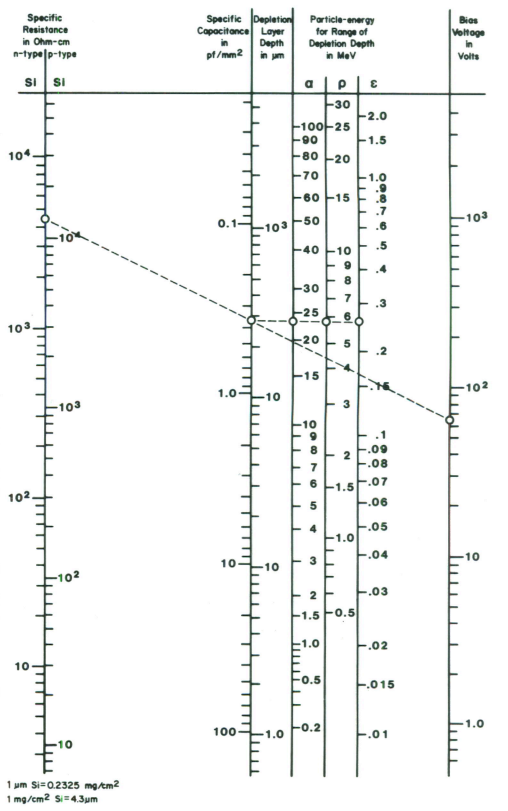
This reverse leakage current increases the detector noise and thus degrades the system energy resolution. Each and every detector supplied by TENNELEC is subjected to stringent quality assurance procedures to assure that no detector has an excessive leakage current.

Bias Voltage Compensation The bias voltage to the detector is always supplied through a series resistor found in the preamplifier for signal isolation. There is a voltage drop across this resistor equal to the product of the leakage current and the series resistor. The bias voltage must be modified upwards to compensate for this drop.

$$V_d = V_a - (I_l \times R_s)$$

V_d = True detector voltage
V_a = Voltage applied
I_l = Detector leakage current
R_s = Preamplifier bias resistor.

Sensitive Depth For charged particle spectroscopy and most other applications, the detector's sensitive depth must be sufficient to completely absorb all of the incident particle's energy. The pulse amplitude generated will then be proportional to the total energy of the charged particle being analyzed. As this sensitive depth increases, the detector capacitance decreases resulting in a decrease in preamplifier noise. This increase in sensitive depth, however, also increases the sensitive volume of the detector which may increase the detectors noise contribution. Sensitive depth, like active area, must be carefully selected to optimize the detector system performance. The nomogram below is similar to the one originally published by J. L. Blankenship, IREE Trans. Vol. NS-7, Nos. 2-3, pp 190-195, June 1960. This nomogram illustrates, among other things, the relationship between sensitive depth, active area and capacitance, as well as the range in silicon for charged particles of varying energies.



Capacitance The major effect of detector capacitance on system performance is its influence on the noise generated by the preamplifier. Additionally, detector capacitance affects the rise time of the preamplifier. Two ways to minimize detector capacitance are to restrict the active area and/or to increase the sensitive depth. In general, a factor of 10 increase in sensitive depth will result in a 10 fold decrease in capacitance in picofarads per mm^2 of active area. For example: 100 μ deep has 1 pf/mm^2; 1000 μ deep has 0.1 pf/mm^2.

Noise and Energy Resolution† There are three major sources of noise in a silicon surface barrier detector.

1. Bulk leakage current
2. Surface leakage current
3. Johnson noise

These noise sources result in spectral peak broadening and therefore a degradation of resolution. These noise sources add in quadrature, so that;

$$(\Delta E_{noise})^2 = (\Delta E_{bulk})^2 + (\Delta E_{surface})^2 + (\Delta E_{Johnson})^2$$

where ΔE represents the peak broadening due to each noise source.

Entrance Window Thickness A charged particle entering a detector must pass through an insensitive region, entrance window, before reaching the active volume of the detector. In passing through this window, an amount of energy will be lost as a function of particle size, energy, window thickness and angle of incidence. As this lost energy is a contributor to detector resolution degradation, the entrance window must be as thin as possible and yet thick enough so as not to compromise good electrical contact.

The entrance window for the TENNELEC PD, PP, TD, TP and HI Series detector is $\leq$40 μgms/cm^2 gold, which is nominally equivalent to 800 angstroms of silicon. Total dead layer does not exceed 20 keV energy loss for 5.486 MeV alpha particles. The exit window of the TD and TP Series detectors is $\leq$40 μgms/cm^2 aluminum, which is nominally equivalent to 2250 angstroms of silicon. The entrance window of the CE Series is $\leq$50 μgms/cm^2 aluminum, which is nominally equivalent to 2300 angstroms of silicon. Contact TENNELEC for light tight or other special entrance window requirements.

CAM-500 and HE Series detectors are usually operated in the counting mode. Entrance window thickness is of minimal concern for this mode of use. Maximum energy loss through these windows is $<$120 keV for 5.486 MeV alpha particles.

The TENNELEC Detector

TENNELEC offers a complete line of Slimline™ detectors featuring low background, increased area, improved geometry, improved resolution and superior timing performance.

Low Background All TENNELEC detectors are specially manufactured and packaged to minimize background problems. TENNELEC accomplishes this through the use of smaller mounting components and using materials which have virtually no naturally occurring radionuclide contaminates.

Increased Area The Slimline™ package does not rob active area from the silicon wafer.

Improved Geometry The Slimline™ design places the detector front electrode less than 1 mm from the front surface of the housing (less than 0.5 mm for unmounted detectors). This means that oblique entry angles are essentially unshadowed by the external package. The housings are thinner than other detectors. This allows larger detectors to be placed into smaller counting chambers and transmission mount detectors can be stacked more closely together.

Improved Resolution Because of our new MIS technology, the Slimline™ detector has lower noise and better energy resolution. This MIS technology reduces the thickness of the silicon oxide layer which reduces the noise and improves the energy resolution.

Superior Timing The Slimline™ detector mount uses no coil springs. Thus, a major inductive component is eliminated from the signal path and thus improves risetime performance to further enhance timing performance.

Detector Description

Partially Depleted (PD) Series detectors are available in a wide range of active areas from 25 mm^2 to 1000 mm^2, and sensitive depths from 100 microns to 1000 microns. (See Table 1). Other sensitive depths and areas are available on special request.

Premium Partially Depleted (PP) Series detectors are the best of the best PD Series detectors and are available in a wide range of active areas from 25 mm^2 to 500 mm^2 and sensitive depths from 100 microns to 500 microns. See Table 2 for a complete selection of available detectors.

Cleanable Front Electrode (CE) Series detectors have a rugged, cleanable aluminum entrance window. These detectors are available in several active areas from 50 mm^2 to 2000 mm^2 and sensitive depths from 100 microns to 1000 microns (See Table 3). Other areas and depletion depths are available on special request.

† From Glenn F. Knoll, "Radiation Detection and Measurement", John Wiley & Sons, New York, 1979, Chapter 11.

Transmission Detector (TD) Series spectrometers are sensitive through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are typically used in ΔE and timing experiments and are offered in a variety of active areas and thicknesses, from 25 mm^2 to 500 mm^2 and 150 microns to 1000 microns (See Table 4). Other thicknesses and areas are available on special request.

All TD Series detectors are cut off-axis from the original crystal to minimize particle channeling. Specified alpha resolutions for detectors <500 microns thick are for 5.486 MeV alpha particles incident through the rear (low field) electrode.

Transmission Planar (TP) Series detectors are totally depleted through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are specially processed for the ultimate in planarity and thickness uniformity across the entire active area. Detectors are available in thicknesses from 40 microns to 100 microns and active areas from 25 mm^2 to 300 mm^2 (See Table 5). Other thicknesses and areas available on special request.

Heavy Ion (HI) Series detectors are partially depleted to a sensitive depth of ≥60 microns and manufactured from silicon with characteristics that withstand extremely high electric field strengths (≥15,000 volts/cm at the entrance window) without introducing surface multiplication effects. Active areas from 100 mm^2 to 1000 mm^2 are available (See Table 6) with other areas available on special request. All HI series detectors are cut off-axis to minimize channeling and come in a close mount (<0.040") configuration. Second category devices with a slightly lower field strength are offered.

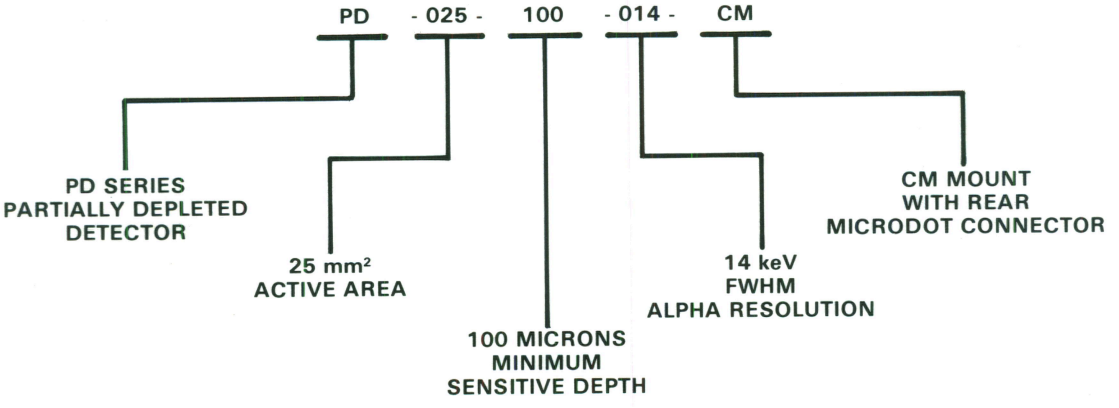
CAM 500 Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors (CAMs). These detectors are resistant to ambient light and cleanable. CAM 500 Series detectors have a 500 mm^2 nominal active area and come in two standard models configured for your mounting needs, the CAM 500B with a rear-mounted female BNC connector and the CAM 500M with a rear-mounted female microdot connector (See Table 7). Other configurations can be supplied on special request.

Harmful Environment (HE) Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors under harmful corrosive gas conditions. The HE 500 Series detectors are configured in the same manner as the CAM 500 Series detectors. In addition, the HE 500 Series are specially treated with a corrosion-resistant polymer coating over the front gold electrode. This dramatically extends the useable lifetime of this detector under corrosive gas conditions, such as hydrofluoric acid. (See Table 8). Other configurations can be supplied on special request.

General Information

Model Number

The TENNELEC model number fully defines the physical and performance specifications of the detector.



Alpha Resolution is warranted as the full peak width at one-half the maximum peak height (Full Width at Half Maximum, FWHM) expressed in keV for Americium - 241, 5.486 MeV alphas. The actual measured resolution will be better than the warranted resolution. Specifications are based on measurements made with standard TENNELEC electronics and an electroplated alpha source and include the electronic noise contribution of the preamplifier.

Beta Resolution is approximately the noise width measured at the FWHM expressed in keV for an electronic pulser peak. Measurements are made with standard TENNELEC electronics and include the electronic noise contribution of the preamplifier.

Collimation Slimline™ detectors are designed so that special collimators can be located to within 1 mm (0.040") of the detector entrance window. Internally mounted collimators can be located to within 0.5 mm (0.020") of the entrance window. For more information on collimators, contact the factory.

Mount Types

TENNELEC Silicon charged particle detectors are available in five (5) standard mount types.

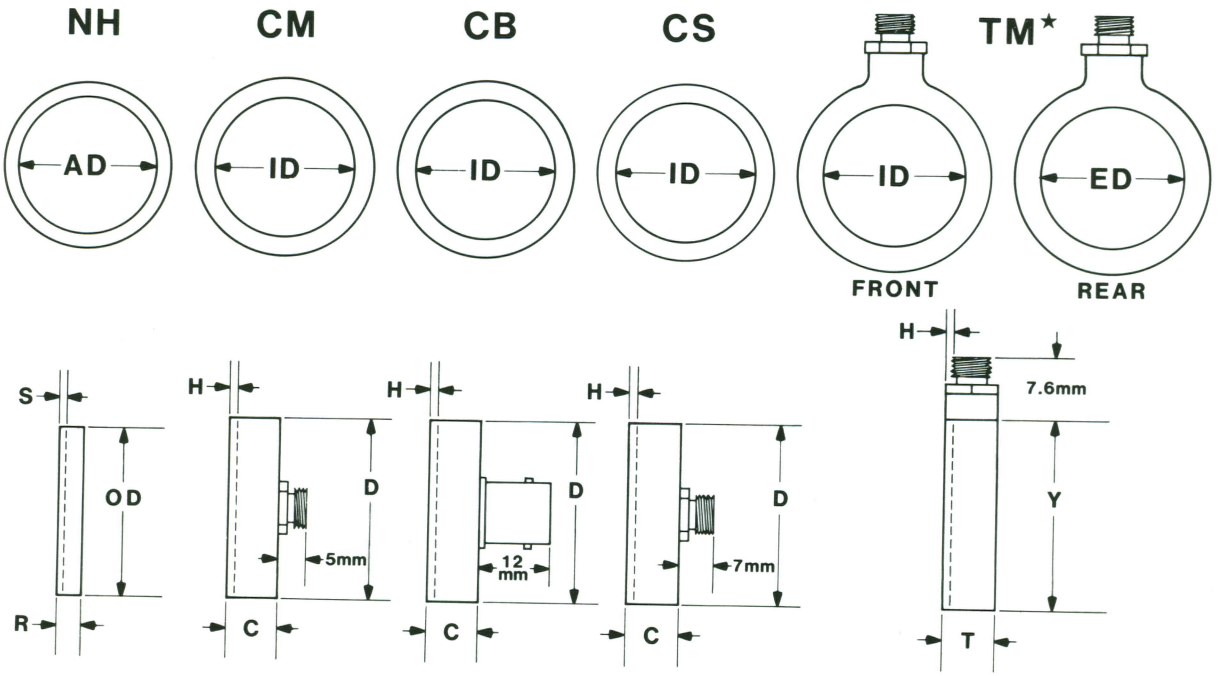
Mount Type	Description
CB	Rear BNC connector
CM	Rear Microdot connector
CS	Rear SMA connector
NH	No housing
TM	Transmission, side microdot connector
TS	Transmission, side SMA connector

mount types are available on special request.

Specifications and Definitions Standards

All TENNELEC specifications and definitions of terms comply with the latest revisions of IEEE/ANSI 300 and IEC 333. Warranted performance is for operation in vacuum at 20°C at the amplifier peaking time (T_p) shown. For modern, high performance amplifiers, T_p is approximately two (2) times the shaping time constant.

Mount Dimensions



Active Area (mm^2)	Active Diameter A.D.±0.2 I.D.†± 0.0 0.2 mm	Exit Opening E.D.±0.1 mm	Outside Diameter ±0.3 mm		
			OD	D	Y
25	5.6	6.9	12.7	16.6	15.1
50	8.0	9.3	14.6	16.6	18.3
100	11.3	12.6	18.4	23.0	20.8
150	13.8	15.1	20.9	23.0	24.9
200	16.0	17.6	23.0	28.4	25.0
300	19.6	20.8	26.2	28.4	28.5
400	22.6	23.8	29.6	32.0	32.0
500	25.3	26.5	32.2	34.3	34.7
600	27.6	28.9	34.1	36.0	37.3
1000	35.7	37.0	43.1	45.2	47.0
2000	50.5	—	59.6	60.9	—

Active Depth (μm)	Front Surface To Det. Spacing ±0.1 mm		Detector Thickness ±0.3 mm		
	S	H	R	C	T
0-600	0.5	1.0	1.5	9.0	7.6
601-1100	1.0	1.6	3.0	12.6	10.0
1200-2100	1.3	1.9	4.6	12.6	12.6

★ SMA connector on transmission type housing available on special order.

† I.D. is provided through a built-in collimator only found with TENNELEC charged particle detectors. This removes the epoxy halo effect and gives you a precise active area.

Table 1. PD Series Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	13	6	PD-25-100-13		PD-25-300-13		PD-25-500-13	
	14	6	PD-25-100-14		PD-25-300-14		PD-25-500-14	
	15	7			PD-25-300-15		PD-25-500-15	
50	14	7	PD-50-100-14		PD-50-300-14		PD-50-500-14	
	15	8	PD-50-100-15		PD-50-300-15		PD-50-500-15	
	17	9	PD-50-100-17		PD-50-300-17		PD-50-500-17	
100	14	7	PD-100-100-14		PD-100-300-14		PD-100-500-14	
	15	8	PD-100-100-15		PD-100-300-15		PD-100-500-15	
	16	9	PD-100-100-16		PD-100-300-16		PD-100-500-16	
150	15	9	PD-150-100-15		PD-150-300-15		PD-150-500-15	
	16	10	PD-150-100-16		PD-150-300-16		PD-150-500-16	
	18	12	PD-150-100-18		PD-150-300-18		PD-150-500-18	
200	16	10	PD-200-100-16		PD-200-300-16		PD-200-500-16	
	17	11	PD-200-100-17		PD-200-300-17		PD-200-500-17	
	19	14	PD-200-100-19		PD-200-300-19		PD-200-500-19	
300	17	13	PD-300-100-17		PD-300-300-17		PD-300-500-17	
	18	14	PD-300-100-18		PD-300-300-18		PD-300-500-18	
	19	15	PD-300-100-19		PD-300-300-19		PD-300-500-19	
400	18	13	PD-400-100-18		PD-400-300-18		PD-400-500-18	
	19	14	PD-400-100-19		PD-400-300-19		PD-400-500-19	
	21	16	PD-400-100-21		PD-400-300-21		PD-400-500-21	
500	19	14	PD-500-100-19		PD-500-300-19		PD-500-500-19	
	21	16	PD-500-100-21		PD-500-300-21		PD-500-500-21	
	25	20	PD-500-100-25		PD-500-300-25			
600	22	18	PD-600-100-22					
	24	19	PD-600-100-24					
1000	39	34	PD-1000-100-39					
	44	39	PD-1000-100-44					
>1000			Special Order					

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]PD Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 2. PP Series Premium Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	12	5	PP-25-100-12		PP-25-300-12		PP-25-500-12	
50	13	6	PP-50-100-13		PP-50-300-13		PP-50-500-13	
100	13	6	PP-100-100-13		PP-100-300-13		PP-100-500-13	
150	14	8	PP-150-100-14		PP-150-300-14		PP-150-500-14	
200	15	9	PP-200-100-15		PP-200-300-15		PP-200-500-15	
300	16	12	PP-300-100-16		PP-300-300-16		PP-300-500-16	
400	17	12	PP-400-100-17		PP-400-300-17		PP-400-500-17	
500	18	13	PP-500-100-18		PP-500-300-18		PP-500-500-18	

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Premium performance guaranteed for 3 months. Best category PD Series performance for equivalent size detector guaranteed for remaining 9 months of one (1) year guarantee.

[3]PP Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 1. PD Series Continued

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Min Sensitive Depth 1000 μm		Min Sensitive Depth >1000 μm
	α	β	Model No.	Price	Model No.
25	13	6	PD-25-1000-13		Special Order
	14	6	PD-25-1000-14		
	15	7	PD-25-1000-15		
50	14	7	PD-50-1000-14		Special Order
	15	8	PD-50-1000-15		
	17	9	PD-50-1000-17		
100	14	7	PD-100-1000-14		Special Order
	15	8	PD-100-1000-15		
	16	9	PD-100-1000-16		
150	15	9	PD-150-1000-15		Special Order
	16	10	PD-150-1000-16		
	18	12	PD-150-1000-18		
200	16	10	PD-200-1000-16		Special Order
	17	11	PD-200-1000-17		
	19	14	PD-200-1000-19		
300	17	13	PD-300-1000-17		
	18	14	PD-300-1000-18		
	19	15			
400	18	13	PD-400-1000-18		
	19	14	PD-400-1000-19		

Table 3. CE Series Cleanable Front Electrode Detectors.

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 100 μm	
	α	β	Model No.	Price
50	15	7	CE-50-100-15	
	17	8	CE-50-100-17	
100	16	10	CE-100-100-16	
	18	11	CE-100-100-18	
150	16	10	CE-150-100-16	
	19	11	CE-150-100-19	
300	19	13	CE-300-100-19	
	21	15	CE-300-100-21	
400	22	17	CE-400-100-22	
	24	19	CE-400-100-24	
500	23	18	CE-500-100-23	
	26	20	CE-500-100-26	
600	25	19	CE-600-100-25	
	33	28	CE-600-100-33	
1000	33	28	CE-1000-100-33	
	40	35	CE-1000-100-40	
2000	50	40	CE-2000-100-50	
	60	55	CE-2000-100-60	

Table 3. CE Series Continued

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 300 μm		Minimum Sensitive Depth 500 μm		Guaranteed Max Resolution (keV)[1]		Minimum-Sensitive Depth 1000 μm	
	α	β	Model No.	Price	Model No.	Price	α	β	Model No.	Price
50	15	7	CE-50-300-15		CE-50-500-15		17	10	CE-50-1000-17	
	17	8	CE-50-300-17		CE-50-500-17					
100	16	10	CE-100-300-16		CE-100-500-16		19	12	CE-100-1000-19	
	18	11	CE-100-300-18		CE-100-500-18					
150	16	10	CE-150-300-16		CE-150-500-16		20	13	CE-150-1000-20	
	19	11	CE-150-300-19		CE-150-500-19					
300	19	13	CE-300-300-19		CE-300-500-19		22	17	CE-300-1000-22	
	21	15	CE-300-300-21		CE-300-500-21					
400	22	17	CE-400-300-22		CE-400-500-22		25	19	CE-400-1000-25	
	24	19	CE-400-300-24		CE-400-500-24					
500	23	18	CE-500-300-23		CE-500-500-23		26	20	CE-500-1000-26	
	26	20	CE-500-300-26		CE-500-500-26					
600	25	19	CE-600-300-25		CE-600-500-25		34	30	CE-600-1000-34	
	33	28	CE-600-300-33		CE-600-500-33					
1000	33	28	CE-1000-300-33		CE-1000-500-33					
	40	35	CE-1000-300-40		CE-1000-500-40					
2000	50	40	CE-2000-300-50		CE-2000-500-50					
	60	55	CE-2000-300-60		CE-2000-500-60					

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]CE Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Transmission Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)							
			150 μm (125-175 μm)		200 μm (176-225 μm)		250 μm (226-275 μm)		300 μm (276-350 μm)	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	15	6	TD-25-150-15		TD-25-200-15		TD-25-250-15		TD-25-300-15	
	16	7	TD-25-150-16		TD-25-200-16		TD-25-250-16		TD-25-300-16	
50	15	6	TD-50-150-15		TD-50-200-15		TD-50-250-15		TD-50-300-15	
	16	7	TD-50-150-16		TD-50-200-16		TD-50-250-16		TD-50-300-16	
100	16	8	TD-100-150-16		TD-100-200-16		TD-100-250-16		TD-100-300-16	
	17	9	TD-100-150-17		TD-100-200-17		TD-100-250-17		TD-100-300-17	
150	17	9	TD-150-150-17		TD-150-200-17		TD-150-250-17		TD-150-300-17	
	18	10	TD-150-150-18		TD-150-200-18		TD-150-250-18		TD-150-300-18	
200	18	10	TD-200-150-18		TD-200-200-18		TD-200-250-18		TD-200-300-18	
	19	13	TD-200-150-19		TD-200-200-19		TD-200-250-19		TD-200-300-19	
300	19	12	TD-300-150-19		TD-300-200-19		TD-300-250-19		TD-300-300-19	
	20	15	TD-300-150-20		TD-300-200-20		TD-300-250-20		TD-300-300-20	
400	23	17	TD-400-150-23		TD-400-200-23		TD-400-250-23		TD-400-300-23	
	24	19	TD-400-150-24		TD-400-200-24		TD-400-250-24		TD-400-300-24	
500	24	18	TD-500-150-24		TD-500-200-24		TD-500-250-24		TD-500-300-24	
	25	20	TD-500-150-25		TD-500-200-25		TD-500-250-25		TD-500-300-25	

[1]Guaranteed alpha resolution is through the rear electrode for thickness ≤500 μm and through the front electrode for thicknesses >500 μm, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]TD Series detectors supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 5. TP Series Transmission Planar Detectors

Active Area (mm^2)	Maximum Thickness Variation (Microns)	Depletion Depth (Range)							
		40 μm (35.1-45 μm)		50 μm (45.1-65 μm)		75 μm (65.1-85 μm)		100 μm (85.1-110 μm)	
		Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	±0.5	TP-25-40-15		TP-25-50-15		TP-25-75-15		TP-25-100-15	
50	±0.5	TP-50-40-20		TP-50-50-15		TP-50-75-15		TP-50-100-15	
100	±1.0	TP-100-40-25		TP-100-50-25		TP-100-75-20		TP-100-100-20	
150	±1.0	TP-150-40-35		TP-150-50-30		TP-150-75-30		TP-150-100-25	
200	±1.0	TP-200-40-40		TP-200-50-35		TP-200-75-35		TP-200-100-25	
300	±1.0	TP-300-40-50		TP-300-50-45		TP-300-75-40		TP-300-100-30	

[1]Last two (2) digits of model number indicate total system noise width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time), for the thinnest detector (highest capacitance) in each thickness range.

[2]TP Series detectors are supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Continued

Depletion Depth (Range)		Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)					
400 μm (351-450 μm)				500 μm (451-550 μm)		700 μm (650-750 μm)		1000 μm (950-1050 μm)	
Model No.	Price	α	β	Model No.	Price	Model No.	Price	Model No.	Price
TD-25-400-15		15	7	TD-25-500-15		TD-25-700-15		TD-25-1000-15	
TD-25-400-16		16	8	TD-25-500-16		TD-25-700-16		TD-25-1000-16	
TD-50-400-15		15	7	TD-50-500-15		TD-50-700-15		TD-50-1000-15	
TD-50-400-16		16	8	TD-50-500-16		TD-50-700-16		TD-50-1000-16	
TD-100-400-16		16	9	TD-100-500-16		TD-100-700-16		TD-100-1000-16	
TD-100-400-17		17	10	TD-100-500-17		TD-100-700-17		TD-100-1000-17	
TD-150-400-17		17	9	TD-150-500-17		TD-150-700-17		TD-150-1000-17	
TD-150-400-18		18	10	TD-150-500-18		TD-150-700-18		TD-150-1000-18	
TD-200-400-18		18	10	TD-200-500-18		TD-200-700-18		TD-200-1000-18	
TD-200-400-19		19	13	TD-200-500-19		TD-200-700-19		TD-200-1000-19	
TD-300-400-19		19	13	TD-300-500-19		TD-300-700-19		TD-300-1000-19	
TD-300-400-20		20	14	TD-300-500-20		TD-300-700-20		TD-300-1000-20	
TD-400-400-23		20	15	TD-400-500-20		TD-400-700-20		Special Order	
TD-400-400-24		22	17	TD-400-500-22		TD-400-700-22			
TD-500-400-24		21	16	TD-500-500-21		TD-500-700-21		Special Order	
TD-500-400-25		23	18	TD-500-500-23		TD-500-700-23			

Table 6. HI Series Heavy Ion Detectors

Active Area (mm^2)	Guaranteed Max Noise (keV)	Minimum Sensitive Depth ≥60 μm			
		Field Strength ≥15 kV/cm		Field Strength ≥10 kV/cm	
		Model No.	Price	Model No.	Price
100	18	HI-100-60-18			
	28			HI-100-60-28	
300	23	HI-300-60-23			
	33			HI-300-60-33	
400	28	HI-400-60-28			
	38			HI-400-60-38	
500	30	HI-500-60-30			
	44			HI-500-60-44	
600	33	HI-600-60-33			
	50			HI-600-60-50	
1000	38	HI-1000-60-38			
	55			HI-1000-60-55	

Note: All HI Series Detectors are ultra-close mount (≤0.040")

[1]Guaranteed max noise is approximated by pulser width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time).

[2]Active surface <1 mm from front of housing.

[3]Performance guaranteed for six (6) months (does not include leakage current increases due to radiation damage).

[4]HI Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 7.
CAM 500 Series Continuous Air Monitoring Alpha Detectors

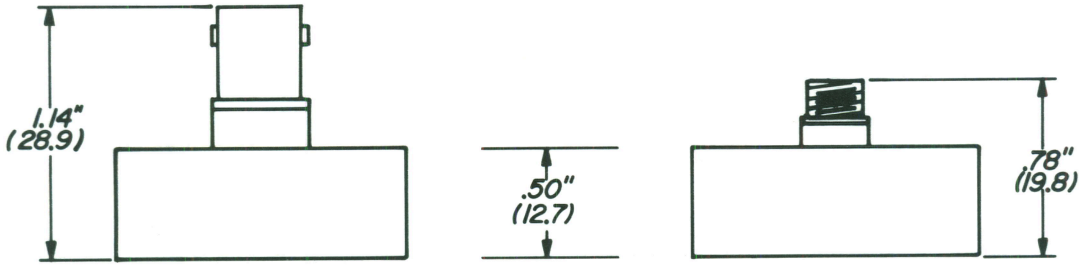
Area (mm^2)	Connector	Model No.	Price
500	BNC	CAM 500 B	
500	Microdot	CAM 500 M	

Table 8.
HE 500 Series Harmful Environment Alpha Detectors

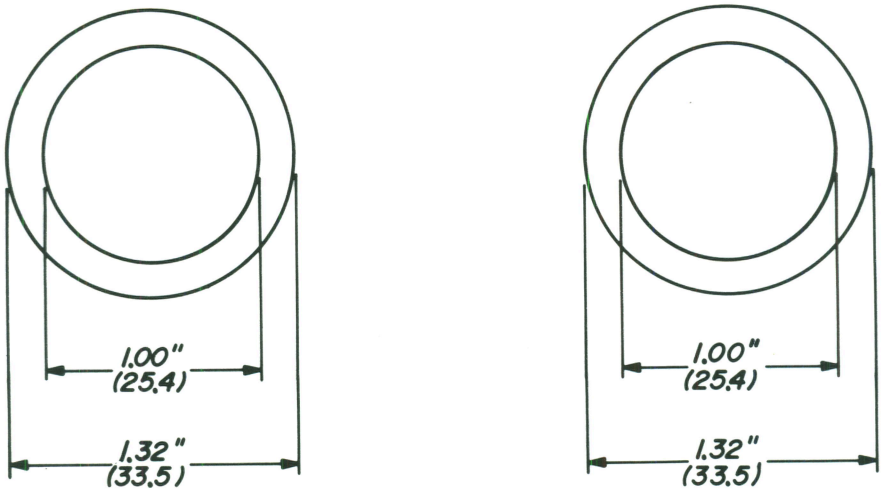
Area (mm^2)	Connector	Model No.	Price
500	BNC	HE 500 B	
500	Microdot	HE 500 M	

CAM 500 and HE 500 Mount Dimensions

CAM 500B **CAM 500M**



BNC *93Ω Microdot*



Price Schedule for Quantity Discounts			
CAM 500 Series		HE 500 Series	
Quantity	Price	Quantity	Price
1 to 9		1 to 9	
10 to 24		10 to 24	
25 to 99		25 to 99	
100 to 199		100 to 199	
200 to 399		200 to 399	
400 and up		400 and up	

Alpha Spectrometers

Component Systems

With the use of TENNELEC's TV-1 Vacuum Chamber and selected electronic NIM modules a high quality Single Channel Alpha System can be configured. This can be a simple counting system with the use of a Single Channel Analyzer (SCA) and Counter and Timer or a Spectroscopy System with the use of a Multichannel Analyzer (MCA). By using a deeper detector, these systems can also be used for Beta detection.

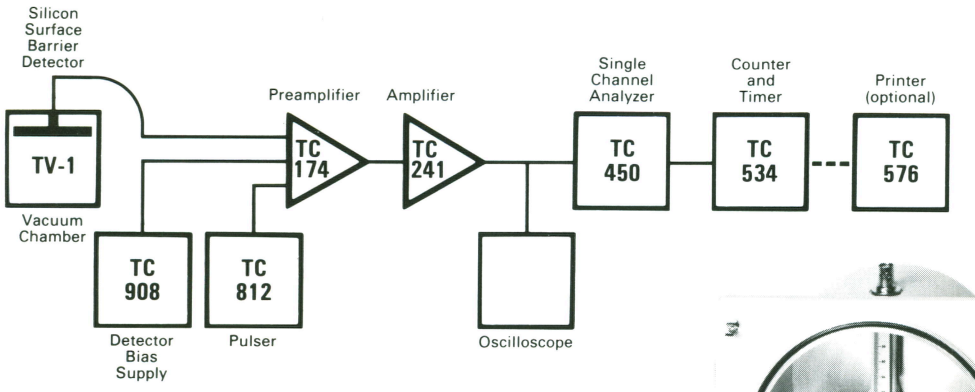
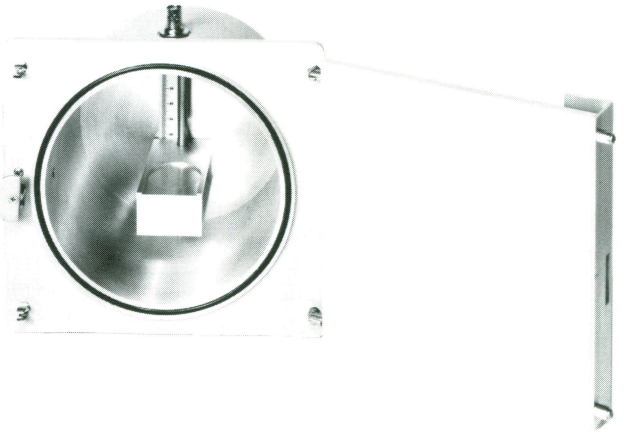


Figure 1
Single Channel Alpha Counting System



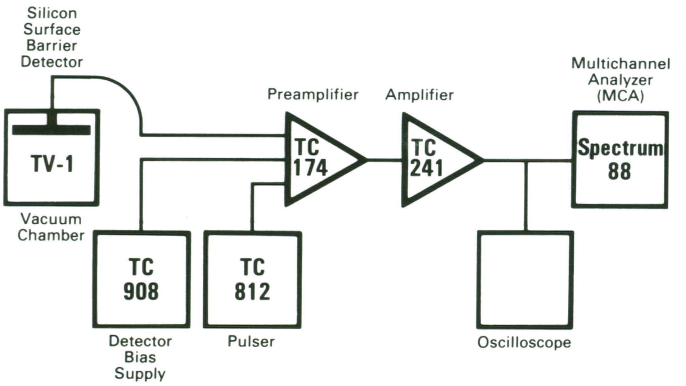
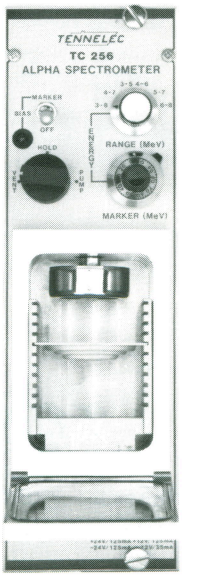


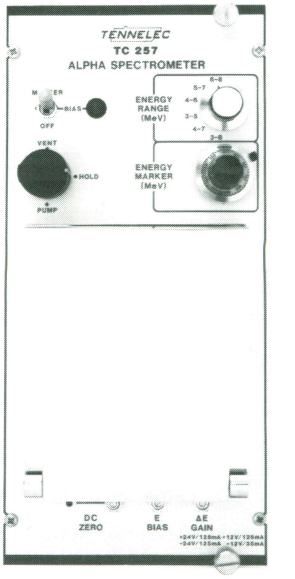
Figure 2
Alpha Spectroscopy System with Multichannel Analyzer (MCA)

Compactly Packaged Systems

TENNELEC produces two complete alpha spectrometers packaged in a double-width NIM module, the TC 256, and a triple-width NIM module, the TC 257. These units contain a vacuum chamber, charge sensitive preamplifier, linear amplifier, discriminator, biased amplifier, variable high voltage supply and adjustable test pulser and are specifically designed for operation with silicon surface barrier detectors.

If you have samples of 1.75 inch diameter or less, the TC 256 is recommended. Should your samples be larger than 1.75 inches, the TC 257 is recommended. The TC 257 will accommodate samples up to 2.25 inches in diameter and accepts the stainless steel sample carriers that are used in TENNELEC's Low Background Alpha/Beta/Gamma counting systems.





Ordering Information

Weight (Shipping) 1.0 lbs (0.45 kg)
(Net) 0.2 lbs (0.09 kg)

Instruction manual and performance test record (one each) provided for each detector shipped.

Accessory included One pair of latex gloves is provided to handle your detector.

Packaging TENNELEC silicon charged particle detectors are covered with a front-electrode protective cap; placed in a polyethylene hinged-lid container and sealed inside of a moisture-proof, 5 mil plastic bag and packed in a cardboard carton before being placed in the appropriate shipping container for the shipping method selected. This packaging technique is suitable for all types of surface and air transportation.

Warranty TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

TENNELEC INC.

601 Turnpike, Oak Ridge, Tennessee 37830
USA
Telephone 615-483-8405/TWX 810-572-1018

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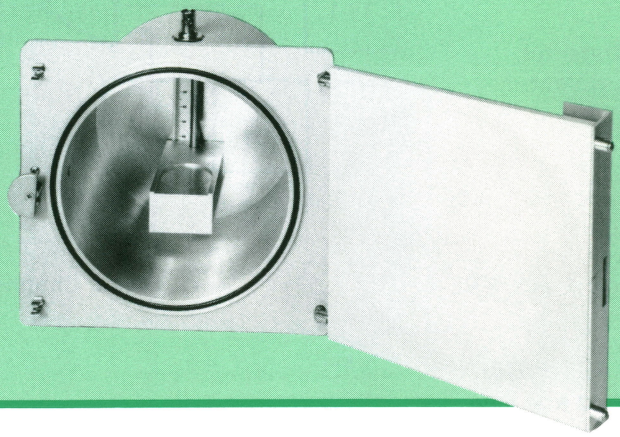
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089/611-5060/TLX 5215959 FRIE D

SG 485 10.0K

TENNELEC

TV-1
Vacuum Chamber

- **Newly redesigned**
- **Front opening hinged door**
- **Adjustable sample holder**
- **Smooth, machined aluminum interior**



DESCRIPTION

The TV-1 is a **newly redesigned** Vacuum Chamber that is useful for Alpha and Beta Spectroscopy with TENNELEC silicon surface barrier detectors. The TV-1 combines ruggedness and ease of operation. The **front opening hinged door** allows easy access to the **adjustable sample holder**. A calibrated scale allows reproducible sample spacings. TENNELEC silicon surface barrier detectors, up to 2000 mm^2, will fit the S-93 (male) microdot vacuum feedthrough connector and the BNC (female) outside connector allows use of standard BNC cables. The **smooth, machined aluminum interior** allows easy cleaning and decontamination.

The TV-1 has a new, three-way PUMP-OFF-VENT valve. The easy to use cam-action provides positive locking in the PUMP position but permits easy opening of the front door. The 0.375" O.D. vacuum port is suitable for use with a standard vacuum hose.

SPECIFICATIONS

SAMPLE SPACING Adjustable from 0 - ~8 cm

SAMPLE SIZE Up to 1.25" diameter

CHAMBER VOLUME Approximately 1400 cc

CONNECTORS BNC (female) to S-93 microdot (male) inside chamber

VALVE Unique three-way, PUMP-OFF-VENT-valve with 0.375" O.D. vacuum connection

ORDERING INFORMATION

WEIGHT (SHIPPING) 11 lbs. (4.9 kg)
(NET) 6 lbs. (2.7 kg)

DIMENSIONS
OUTSIDE: 7.25" W x 7" H x 6.5" D (18.4 cm W x 17.8 cm H x 16.5 cm D)

INSIDE: 5.25" Diameter x 4" Deep (13.3 cm Diameter x 10.2 cm Deep)

WARRANTY One year

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TV-1 Vacuum Chamber

APPLICATION NOTES:

The following additional equipment is required for alpha/beta counting and spectroscopy systems.

NIM Bin and Power Supply Tennelec Model TB 3/TC 911

Silicon Surface Barrier Detector PD-25-100-17-CM or equivalent

Vacuum Pump

Radioactive Alpha Source ~0.1 μCi ^{210}Po or ^{241}Am or equivalent

Radioactive Beta Source ~1 μCi ^{207}Bi, ^{137}Cs or equivalent

Cables and Connectors
1-NC-594-02 SHV to BNC, 2 feet long
1-NC-595-06 SHV to SHV, 6 feet long
1-NC-581-06 BNC to BNC, 6 feet long
1-NC-TEE BNC TEE Connector
3-6 NC-581-01 BNC to BNC, 1 foot long

Beta counting or beta spectroscopy may be performed with the replacement of Tennelec Model PD-25-100-17-CM with a Tennelec Model PD-25-1000-18-CM silicon surface barrier detector in the systems illustrated in either figure 1 or figure 2.

TYPICAL APPLICATIONS

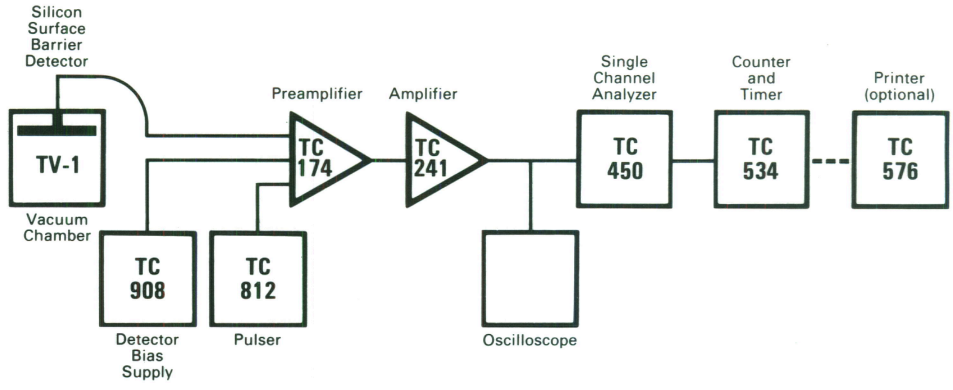


Figure 1
Single Channel Alpha Counting System

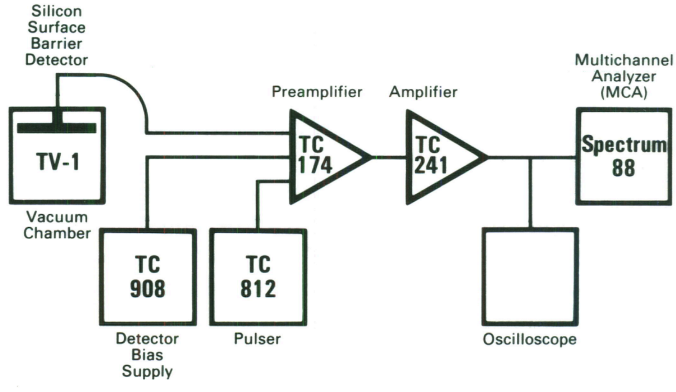
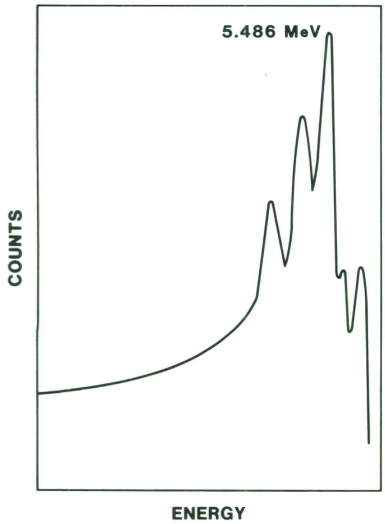
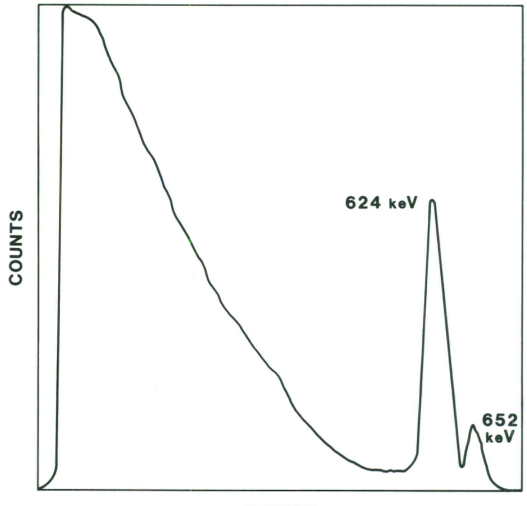


Figure 2
Alpha Spectroscopy System with Multichannel Analyzer (MCA)



^{241}Am ALPHA SPECTRUM

Typical Alpha Spectrum



CONVERSION ELECTRON AND BETA SPECTRUM OF ^{137}Cs

Typical Beta Spectrum

TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

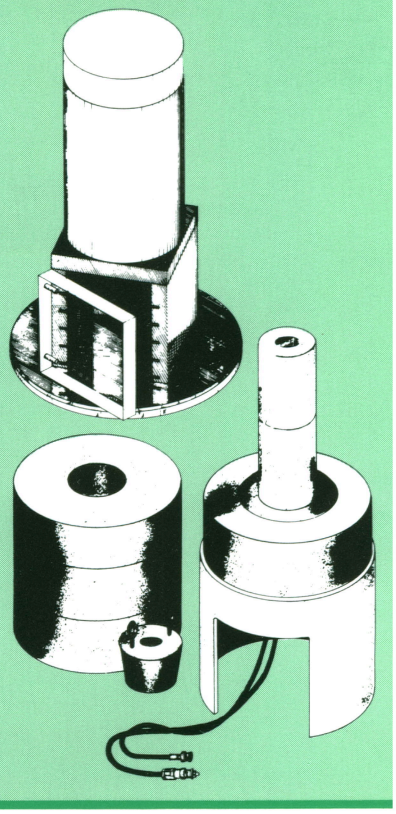
TENNELEC

Lea
Counting Shield

DESCRIPTION

TENNELEC offers a **complete line of lead counting shields** for NaI (Tl), GM and proportional counter detectors. Only the **lowest background virgin lead** is used to ensure the best possible shielding. All exterior portions of the lead shield are coated with a **durable enamel-based paint** for ease of handling and decontamination.

- **Complete line of lead counting shields**
- **Low background virgin lead construction**
- **Exterior coated with durable, enamel-based paint**

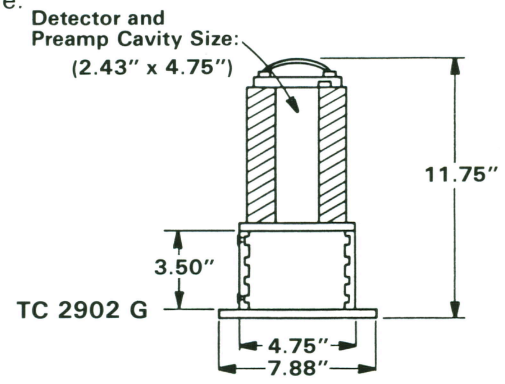


TC 2902 G This assembly is designed for 1" diameter end window GM and proportional counter detectors. The TC 2902 G consists of a 4.5" diameter x 4.75" long lead shield supported by an aluminum base. Grooves are provided in the base to hold planchets or sample trays in any of five positions. The detector faces downward and a removable top is provided for ease of insertion and cabling of the detector. The TC 2902 G is physically small enough to be used on any laboratory bench or table.

ORDERING INFORMATION

WEIGHT

Shipping	35 lbs. (15.9 kg)
Net	28 lbs. (12.7 kg)
Diameter	8 inches
Height	12 inches

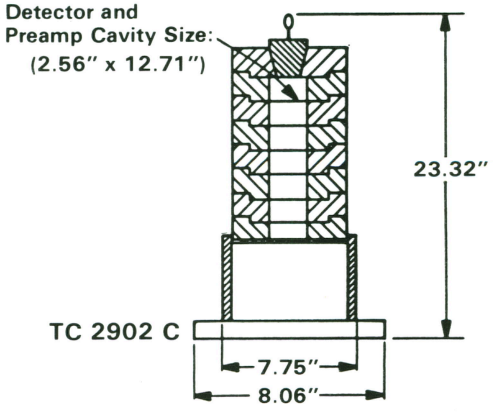


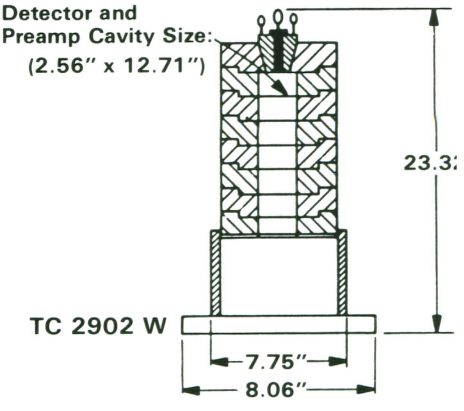
TC 2902 C, TC 2902 W Designed for use with 1" or 2" diameter NaI (Tl) detectors, the TC 2902 C and TC 2902 W shields are sectional and therefore easy to move and assemble. All sections are 6" diameter doughnut shaped and are stacked on top of a stand to fabricate the shield. The stand has a large opening for cable access. The upper-most "doughnut" has a tapered hole and lead plug. If a standard NaI (Tl) detector is to be used, a model TC 2902 C shield should be ordered and a solid plug will be provided. If a well detector will be used, a TC 2902 W shield should be ordered and a top plug with a 1" diameter straight through hole will be provided. This hole allows for sample insertion into the detector well.

ORDERING INFORMATION

WEIGHT

Shipping	185 lbs. (84.1 kg)
Net	158 lbs. (71.8 kg)
Diameter	8 inches
Height	23 inches





TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

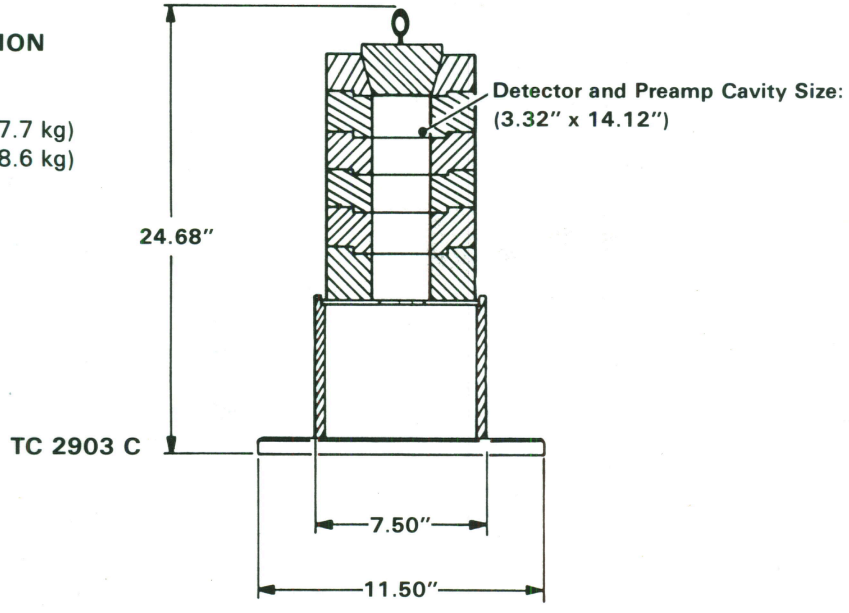
Lead Counting Shields

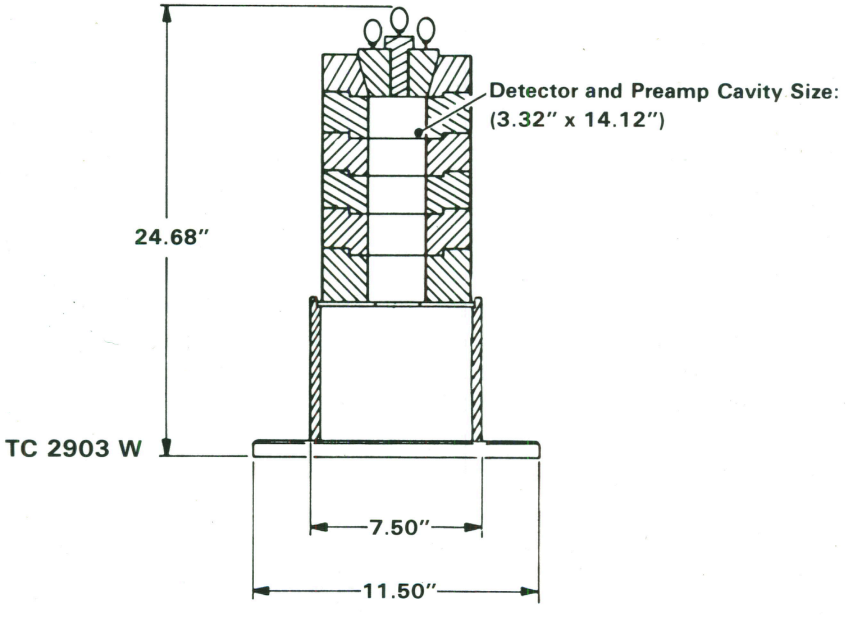
TC 2903 C, TC 2903 W The TC 2903 C and TC 2903 W shields are of the same design as the TC 2902 C and W except they are intended for 3 inch diameter standard and well NaI (Tl) detectors. The doughnut shaped sections for both shields are 7" in diameter.

ORDERING INFORMATION

WEIGHT

Shipping	215 lbs. (97.7 kg)
Net	195 lbs. (88.6 kg)
Diameter	12 inches
Height	25 inches





TENNELEC INC.
TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.
PHONE 615-483-8405 TWX 810-572-1018

SOLID and SOLUTION RADIOISOTOPES

for education, research, and instrument checks

the Nucleus® INC.

REPRESENTED BY:

761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-2561 USA
TELEPHONE 615-483-0008 TLX 557-482

Solution Sources

All liquid radioisotopes are supplied as 5 milliliters of solution in glass vials with screw caps sealed by teflon tape. Each nuclide is carrier free, of the highest radiopurity available, and is dissolved in sufficient concentrations of HCl, HNO^3, or water, to insure stability over the useful life of the nuclide. A label affixed to the glass vial identifies the radionuclide, the total amount of activity, the solution in which the nuclide is mixed, and the date of preparation (for long half-life nuclides), or the date of calibration (for short half-life nuclides). Radionuclide solutions as listed are within ±20% of the stated activity. No specific radioactive materials license is required to purchase liquid sources, and up to 10 bottles of any particular isotope may be shipped in any single order. Please refer to the "Licensing Requirements" section for a discussion of "license free" or "license exempt" shipments. Since all solution sources are dispensed to order, requests for specific packaging can normally be accommodated.

LONG HALF-LIFE SOLUTION SOURCES:

Model No.	Nuclide	Activity	Half-Life	Radiation
Ba-133-L	Barium Chloride (Ba-133)	1 μCi	7.2 y	γ, EC
Cd-109-L	Cadmium Chloride (Cd-109)	1 μCi	1.4 y	EC, γ
C-14-L	Sodium Carbonate (C-14)	10 μCi	5568 y	β
Cs-137-L	Cesium Chloride (Cs-137)	5 μCi	30 y	β, γ
Co-57-L	Cobaltous Chloride (Co-57)	1 μCi	270 d	β+, γ
Co-60-L	Cobaltous Chloride (Co-60)	1 μCi	5.26 y	β, γ
Eu-155-L	Europium Chloride (Eu-155)	1 μCi	1.8 y	β, γ
Fe-55-L	Ferric Chloride (Fe-55)	10 μCi	2.7 y	EC
Pb-210-L	Lead Nitrate (Pb-210)	0.1 μCi	22 y	α, β, γ
Mn-54-L	Manganese Chloride (Mn-54)	1 μCi	310 d	γ, EC
Pm-147-L	Promethium Chloride (Pm-147)	10 μCi	2.6 y	β
Na-22-L	Sodium Chloride (Na-22)	1 μCi	2.6 y	β+, γ, EC
Sr-90-L	Strontium Chloride (Sr-90)	0.1 μCi	28 y	β
Tl-204-L	Thallous Sulfate (Tl-204)	10 μCi	3.8 y	β, EC
U-238	Uranyl Nitrate (Solid)	5 grams	4.5×10^9 y	α, β, γ
Zn-65-L	Zinc Chloride (Zn-65)	10 μCi	245 d	β+, EC, γ

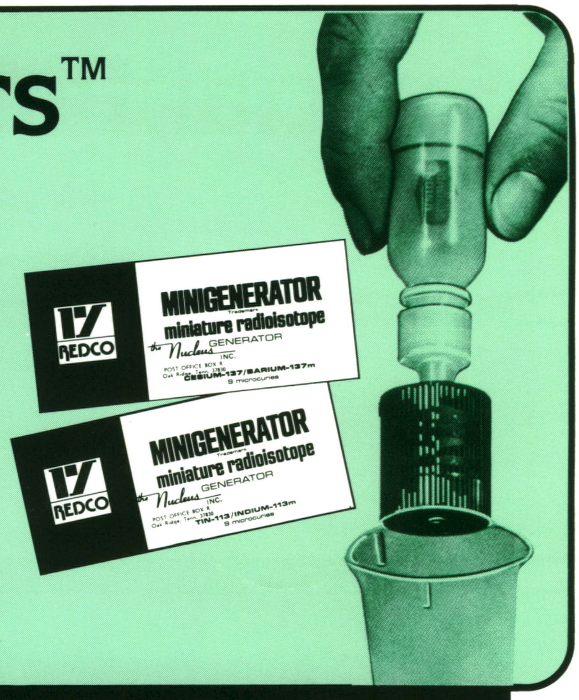
SHORT HALF-LIFE SOLUTION SOURCES:

Radioisotopes are normally sent by first class mail and are shipped approximately one week prior to the requested delivery date. However, the activity of the particular nuclide is calibrated for the date requested, which is indicated on the bottle label. Please allow at least one week for transit time on short half-life radioisotopes.

Model No.	Nuclide	Activity	Half-Life	Radiation
Ca-45-L	Calcium Chloride (Ca-45) (in Water)	10 μCi	165 d	β
I-131-L	Sodium Iodide (I-131)	1 μCi	8 d	β, γ
P-32-L	Orthophosphoric Acid (P-32)	10 μCi	14 d	β
Po-210-L	Polonium Chloride (Po-210)	0.1 μCi	138 d	α

Minigenerators™

Radioisotope generators have long been routinely used in diagnostic medicine, and now three separate radioisotope generators are available for classroom use in teaching the fundamentals of radiation detection, radioactive decay, and similar basic nuclear principles. MINIGENERATORS are miniaturized radioisotope generators which provide instant short half-life nuclides for student experiments. Each miniature system contains a long-lived radionuclide that decays to a short-lived radionuclide. The original nuclide, called the parent, is kept permanently fixed within the MINIGENERATOR, and by passing a solution through the parent, a shorter-lived radionuclide (called the daughter), is removed. Because the parent is continually decaying to the daughter, the MINIGENERATOR will "recharge" itself, so the system may be reused time after time during the school year. Each MINIGENERATOR contains an amount of parent activity which is exempt from state and federal licensing requirements.



MINIGENERATOR SYSTEMS AND MANUALS

Cs-137-M-2: CESIUM-137/BARIUM-137m MINIGENERATOR

Parent: Cs-137, 30 years; Daughter: Ba-137m, 2.6 minutes
Elutant: 0.04N HCl and 0.9% NaCl
Specific Activity of Daughter: Carrier free
Activity of Parent: 9 μCi
Energy of Radiation: Gamma, 662 keV

Sn-113-M-1: TIN-113/INDIUM-113m MINIGENERATOR

Parent: Sn-113, 115 days; Daughter: In-113m, 100 minutes
Elutant: 0.04N HCl and 0.9% NaCl
Specific Activity of Daughter: Carrier free
Activity of Parent: 9 μCi
Energy of Radiation: Gamma, 393 keV

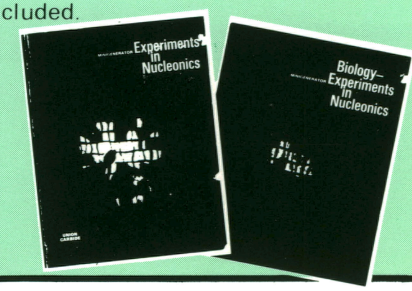
Sr-90-M-1: STRONTIUM-90/YTTRIUM-90 MINIGENERATOR

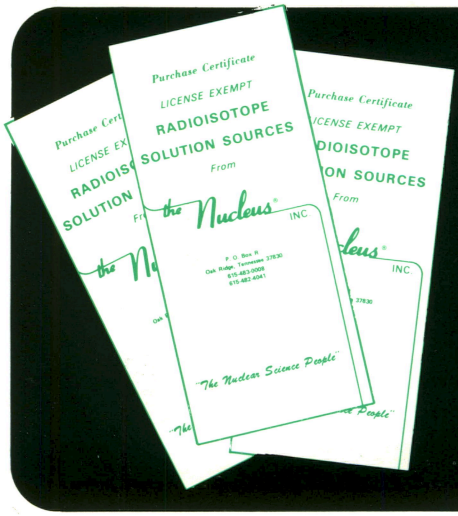
Parent: Sr-90, 28 years; Daughter: Y-90, 64 hours
Elutant: 0.1% EDTA
Specific Activity of Daughter: Carrier free
Activity of Parent: 0.09 μCi
Energy of Radiation: Beta, 2.3 MeV maximum

Each MINIGENERATOR system comes with an instruction booklet for the user, describing the nuclear characteristics of the MINIGENERATOR, operating instructions, and definitions of some nuclear terms. Directions for preparing the eluting solution are included.

Two manuals containing experiments designed to be performed by students during a typical laboratory period utilizing the MINIGENERATORS are available for basic studies and for biology studies. Both manuals contain a teacher's guide for each experiment.

Manual 1 — EXPERIMENTS IN NUCLEONICS; 120 pages
Manual 2 — EXPERIMENTS IN NUCLEONICS - BIOLOGY; 128 pages



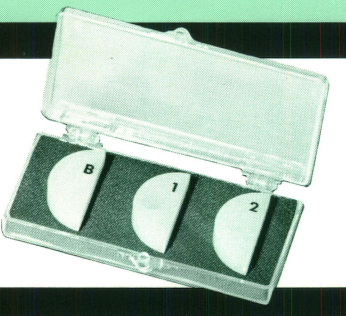


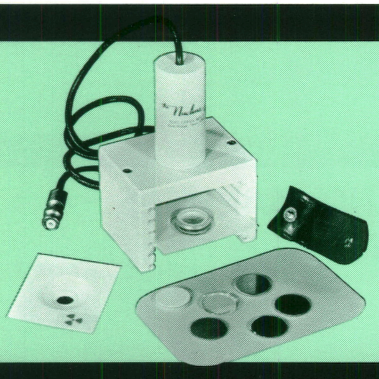
Radioisotope Coupons: Most often institutional procedures regarding the purchasing of supplies (processing requisitions and issuing purchase orders) are time-consuming. By the time the order reaches us, your need for a radioisotope in a scheduled laboratory experiment has already passed – or we receive the request too late to insure arrival by the requested date. To eliminate such problems, The Nucleus offers RADIOISOTOPE PURCHASE CERTIFICATES (our customers call them "coupons") which may be redeemed upon request for any of our solution sources. These coupons may be purchased individually in any number. When you require a specific isotope, simply check off the requested nuclide and mail your certificate to us, indicating the date the material is to be used. We will process your order and send the solution source to arrive when needed. Please allow enough time for the coupon to reach us and for the return shipment to reach you – normally 12 to 15 days is sufficient. Prices for Radioisotope Purchase Certificates are the same as for the solution source model listed.

Special Purpose Sources

The Nucleus offers a variety of custom packaging to meet our customers' specific requirements. If you need a special configuration source, we will be happy to discuss your specifications. Several of our most popular special purpose sources which are routinely available are described below:

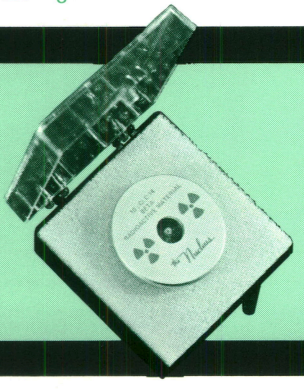
Model S-9: Split Source Set; for resolving time measurements to demonstrate the dead-time of a GM tube. Set includes two identical half-disc plastic sealed sources, each containing 5 μCi of Tl-204. A third half-disc (non-radioactive) is included to give uniform geometry when used with either of the two radioactive half-discs. Total activity of set is 1 exempt quantity.





Model S-10: Backscatter Kit; A favorite experiment to demonstrate the backscattering effects of beta radiation and determine relative effects on atomic number, thickness of backing material, and energy level of beta radiation. Complete kit includes seven backscatter materials; aluminum, copper, glass, lead, nickel-plated steel, plastic and stainless steel. A thin mylar-covered sealed source containing .5 μCi of Tl-204 is provided, along with leather storage pouch. Photograph pictures typical GM set-up using Model S-10 backscatter kit.

Model S-11: Cloud Chamber Source Set; includes one alpha (.1 μCi Po-210) and one beta (.1 μCi Sr-90) needle source mounted in color-coded rubber stoppers. Activity is deposited on end of needles. Rubber stoppers fit into end of plastic tube for convenient storage.



Thin mylar covered source disc for low energy beta studies. Radioactivity is deposited in center of .0015 inch mylar film, dried, and covered with similar thickness mylar. Sealed in aluminum planchet, 1 inch diameter, with identification label.

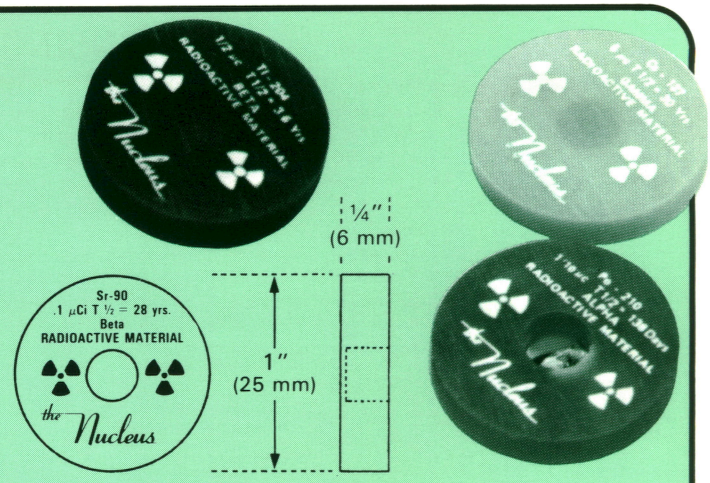
Model S-12: Carbon-14, 10 μCi C-14, T½ = 5570 years
Model S-14: Lead-210, 0.1 μCi Pb-210, T½ = 22 years

Model S-13: Student Scintillation Spectrometry Gamma Source Set; includes 8 gamma emitters:

1 ea. Co-60-S
1 ea. Na-22-S
1 ea. Mn-54-S
1 ea. Cs-137-S-1
1 ea. Ba-133-S
1 ea. Cd-109-S
1 ea. Co-57-S
1 ea. "unknown" - mixture of Cs-137 and Zn -65
Provides a wide assortment of gamma energies for student identification.
Comes with convenient wood storage case.

Solid Sources

Safe, inexpensive, uncalibrated solid sealed sources are fabricated using acrylic plastic discs. A license exempt quantity of activity is deposited in the well of a 1 inch diameter (25 mm) by ¼ inch thick (6 mm) color-coded plastic disc. After evaporation, the well is filled with a clear epoxy material which totally seals the radioactivity inside the source. Each disc is identified by radionuclide, amount of activity, half-life, and type radiation. The words "Radioactive Material" appear on the flat surface of the source disc. For easy identification of the radiation type, disc sources are color-coded: red - ALPHA, green - BETA, and orange - GAMMA. Uncalibrated solid sources contain ±20% of the stated activity and are routinely compared to NBS standards.



Actual Size

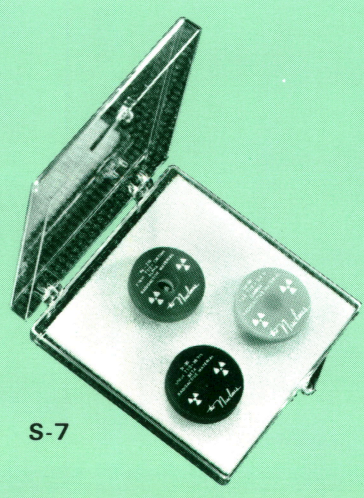
SINGLE SOURCE MODELS:

Model No.	Nuclide	Activity	Half-Life	Radiation
Ba-133-S	Barium - 133	1 μCi	7.2 y	EC, γ
Cd-109-S	Cadmium - 109	1 μCi	1.4 y	EC, γ
Cs-137-S-1	Cesium - 137	1 μCi	30 y	β, γ
Cs-137-S-5	Cesium - 137	5 μCi	30 y	β, γ
Co-57-S	Cobalt - 57	1 μCi	272 d	EC, γ
Co-60-S	Cobalt - 60	1 μCi	5.24 y	β, γ
Mn-54-S	Manganese - 54	1 μCi	312 d	EC, γ
Na-22-S	Sodium - 22	1 μCi	2.6 y	EC, β+, γ
Po-210-S	Polonium - 210	0.1 μCi	138.4 d	α, γ
Sr-90-S	Strontium - 90	0.1 μCi	28.8 y	β
Tl-204-S-1	Thallium - 204	1 μCi	3.75 y	EC, β
Tl-204-S-10	Thallium - 204	10 μCi	3.75 y	EC, β
Zn-65-S	Zinc - 65	1 μCi	243 d	EC, β+, γ

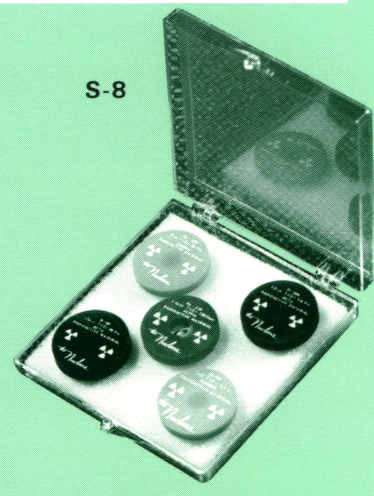
COMPLETE SOLID SOURCE SETS:

Model S-7: Alpha, beta, gamma set includes one alpha (Po-210-S), one beta (Sr-90-S), and one gamma (Co-60-S) packaged in clear plastic box suitable for storage. Total of three sources, 3 exempt quantities.

Model S-8: Alpha, 2 beta, 2 gamma set includes:
one alpha (Po-210-S)
one beta (Sr-90-S)
one beta (Tl-204-S-1)
one gamma (Co-60-S)
one gamma (Cs-137-S-5)
Packaged in clear plastic box suitable for storage. Total of 5 sources, 3.6 exempt quantities.



S-7



S-8

LICENSING REQUIREMENTS

§30.18 Exempt quantities.

(a) Except as provided in paragraphs (c) and (d) of this section, any person is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in Parts 30-34 of this chapter to the extent that such person receives, possesses, uses, transfers, owns, or acquires byproduct material in individual quantities each of which does not exceed the applicable quantity set forth in § 30.71, Schedule B.

(b) Any person who possesses byproduct material received or acquired prior to October 22, 1970 under the general license then provided in § 31.4 of this chapter is exempt from the requirements for a license set forth in section 81 of the Act and from the regulations in Parts 30-34 of this chapter to the extent that such person possesses, uses, transfers or owns such byproduct material.

(c) This section does not authorize the production, packaging, repackaging, or import of byproduct material for purposes of commercial distribution, or the incorporation of byproduct material into products intended for commercial distribution.

(d) No person may, for purposes of commercial distribution import or transfer byproduct material in the individual quantities set forth in § 30.71 Schedule B, knowing or having reason to believe that such quantities of byproduct material will be transferred to persons exempt under this section or equivalent regulations of an Agreement State, except in accordance with a license issued under § 32.18 of this chapter, which license states that the byproduct material may be transferred by the license to persons exempt under this section or the equivalent regulations of an Agreement State.

§ 30.71 Schedule B.

Byproduct material	Microcuries
Antimony 122 (Sb 122)	100
Antimony 124 (Sb 124)	10
Antimony 125 (Sb 125)	10
Arsenic 73 (As 73)	100
Arsenic 74 (As 74)	10
Arsenic 76 (As 76)	10
Arsenic 77 (As 77)	100
Barium 131 (Ba 131)	10
Barium 140 (Ba 140)	10
Bismuth 210 (Bi 210)	1
Bromine 82 (Br 82)	10
Cadmium 109 (Cd 109)	10
Cadmium 115m (Cd 115m)	10
Cadmium 115 (Cd 115)	100
Calcium 45 (Ca 45)	10
Calcium 47 (Ca 47)	10
Carbon 14 (C 14)	100
Cerium 141 (Ce 141)	100
Cerium 143 (Ce 143)	100
Cerium 144 (Ce 144)	1
Cesium 131 (Cs 131)	1,000
Cesium 134m (Cs 134m)	100
Cesium 134 (Cs 134)	1
Cesium 135 (Cs 135)	10
Cesium 136 (Cs 136)	10
Cesium 137 (Cs 137)	10
Chlorine 36 (Cl 36)	10
Chlorine 38 (Cl 38)	10
Chromium 51 (Cr 51)	1,000
Cobalt 58m (Co 58m)	10
Cobalt 58 (Co 58)	10
Cobalt 60 (Co 60)	1
Copper 64 (Cu 64)	100
Dysprosium 165 (Dy 165)	10
Dysprosium 166 (Dy 166)	100
Erbium 169 (Er 169)	100
Erbium 171 (Er 171)	100
Europium 152 9.2 h (Eu 152 9.2 h)	100
Europium 152 13 yr (Eu 152 13 yr)	1
Europium 154 (Eu 154)	1
Europium 155 (Eu 155)	10
Fluorine 18 (F 18)	1,000
Gadolinium 153 (Gd 153)	10
Gadolinium 159 (Gd 159)	100
Gallium 72 (Ga 72)	10
Germanium 71 (Ge 71)	100
Gold 198 (Au 198)	100
Gold 199 (Au 199)	100
Hafnium 181 (Hf 181)	10
Holmium 166 (Ho 166)	100
Hydrogen 3 (H 3)	1,000
Indium 113m (In 113m)	100
Indium 114m (In 114m)	10
Indium 115m (In 115m)	100
Indium 115 (In 115)	10
Iodine 125 (I 125)	1
Iodine 126 (I 126)	1
Iodine 129 (I 129)	0.1
Iodine 131 (I 131)	1
Iodine 132 (I 132)	10
Iodine 133 (I 133)	1
Iodine 134 (I 134)	10
Iodine 135 (I 135)	10
Iridium 192 (Ir 192)	10
Iridium 194 (Ir 194)	100
Iron 55 (Fe 55)	100
Iron 59 (Fe 59)	10
Krypton 85 (Kr 85)	100
Krypton 87 (Kr 87)	10
Lanthanum 140 (La 140)	10
Lutetium 177 (Lu 177)	100
Manganese 52 (Mn 52)	10
Manganese 54 (Mn 54)	10
Manganese 56 (Mn 56)	10
Mercury 197m (Hg 197m)	100
Mercury 197 (Hg 197)	100
Mercury 203 (Hg 203)	10
Molybdenum 99 (Mo 99)	100
Neodymium 147 (Nd 147)	100
Neodymium 149 (Nd 149)	100
Nickel 59 (Ni 59)	100
Nickel 63 (Ni 63)	10
Nickel 65 (Ni 65)	100
Niobium 93m (Nb 93m)	10
Niobium 95 (Nb 95)	10
Niobium 97 (Nb 97)	10
Osmium 185 (Os 185)	10
Osmium 191m (Os 191m)	100
Osmium 191 (Os 191)	100
Osmium 193 (Os 193)	100
Palladium 103 (Pd 103)	100
Palladium 109 (Pd 109)	100
Phosphorus 32 (P 32)	10
Platinum 191 (Pt 191)	100
Platinum 193m (Pt 193m)	100
Platinum 193 (Pt 193)	100
Platinum 197m (Pt 197m)	100
Platinum 197 (Pt 197)	100
Polonium 210 (Po 210)	0.1
Potassium 42 (K 42)	10
Praseodymium 142 (Pr 142)	100
Praseodymium 143 (Pr 143)	100
Promethium 147 (Pm 147)	10
Promethium 149 (Pm 149)	10
Rhenium 186 (Re 186)	100
Rhenium 188 (Re 188)	100
Rhodium 103m (Rh 103m)	100
Rhodium 105 (Rh 105)	100
Rubidium 86 (Rb 86)	10
Rubidium 87 (Rb 87)	10
Ruthenium 97 (Ru 97)	10
Ruthenium 103 (Ru 103)	10
Ruthenium 105 (Ru 105)	10
Ruthenium 106 (Ru 106)	1
Samarium 151 (Sm 151)	10
Sanarium 153 (Sm 153)	100
Scandium 46 (Sc 46)	10
Scandium 47 (Sc 47)	100
Scandium 48 (Sc 48)	10
Selenium 75 (Se 75)	10
Silicon 31 (Si 31)	100
Silver 105 (Ag 105)	10
Silver 110m (Ag 110m)	1
Silver 111 (Ag 111)	100
Sodium 24 (Na 24)	10
Strontium 85 (Sr 85)	10
Strontium 89 (Sr 89)	1
Strontium 90 (Sr 90)	0.1
Strontium 91 (Sr 91)	10
Strontium 92 (Sr 92)	10
Sulphur 35 (S 35)	100
Tantalum 182 (Ta 182)	10
Technetium 96 (Tc 96)	10
Technetium 97m (Tc 97m)	100
Technetium 97 (Te 97)	100
Technetium 99m (Tc 99m)	100
Technetium 99 (Tc 99)	10
Tellurium 125m (Te 125m)	10
Tellurium 127m (Te 127m)	10
Tellurium 127 (Te 127)	100
Tellurium 129m (Te 129m)	10
Tellurium 129 (Te 129)	100
Tellurium 131m (Te 131m)	10
Tellurium 132 (Te 132)	10
Terbium 160 (Tb 160)	10
Thallium 200 (Tl 200)	100
Thallium 201 (Tl 201)	100
Thallium 202 (Tl 202)	100
Thallium 204 (Tl 204)	10
Thulium 170 (Tm 170)	10
Thulium 171 (Tm 171)	10
Tin 113 (Sn 113)	10
Tin 125 (Sn 125)	10
Tungsten 181 (W 181)	10
Tungsten 185 (W 185)	10
Tungsten 187 (W 187)	100
Vanadium 48 (V 48)	10
Xenon 131m (Xe 131m)	1,000
Xenon 133 (Xe 133)	100
Xenon 135 (Xe 135)	100
Ytterbium 175 (Yb 175)	100
Yttrium 90 (Y 90)	10
Yttrium 91 (Y 91)	10
Yttrium 92 (Y 92)	100
Yttrium 93 (Y 93)	100
Zinc 65 (Zn 65)	10
Zinc 69m (Zn 69m)	100
Zinc 69 (Zu 69)	1,000
Zirconium 93 (Zr 93)	10
Zirconium 95 (Zr 95)	10
Zirconium 97 (Zr 97)	10
Any byproduct material not listed above other than alpha emitting byproduct material	0.1
* Barium 133 (Ba 133)	10

NOTE: No more than 10 exempt quantities set forth in § 30.71, Schedule B of this chapter shall be sold or transferred in any single transaction. For purposes of this requirement, an individual exempt quantity may be composed of fractional parts of one or more of the exempt quantities in § 30.71, Schedule B, provided that the sum of such fractions shall not exceed unity.

Quantities of byproduct material in excess of the amounts specified § 30.71 Schedule B above cannot be supplied unless a copy of the customer's specific license to possess the material is on file with the supplier.

ORDERING INFORMATION

Radioisotopes provides exciting laboratory experiments for students at all levels. The Nucleus, recognizing the need for a source of safe and economical radioactive materials, offers a wide variety of license exempt radioisotopes for student experimentation.

Licensing: All student educational sources supplied by The Nucleus contain an amount of radioactivity which may be procured, handled, and used by individuals who are exempt from U.S. Nuclear Regulatory Commission or State licensing requirements. Consequently, these small quantities of radioisotopes are referred to as "license-free" or "exempt quantity" sources.

Excerpts from USNRC regulations, and a list of the maximum exempt quantities for radioisotopes are reproduced above. All sources, either liquid or solid, with activities not excceeding those listed in § 30.71 Schedule B are considered "exempt quantities" and no license is required to purchase these sources. Further, USNRC regulations state that no more than 10 exempt quantities may be purchased in any single transaction. For example, we can ship 10 vials of I-131, each containing 1 μCi of activity (1 exempt quantity), on a single order; we cannot, however, ship 1 vial containing 10 μ Ci of activity since this exceeds the 1 μCi exempt quantity for I-131.

Ordering: Radioisotopes are ordered just like any other product. Please include the following information.

1. Model number and name of nuclide desired.
2. Number of sources requested.
3. Purchase order number.
4. Ship to and bill to address.
5. Desired shipping or calibration date.

The Nucleus, Inc.
P.O. Box 2561 • Oak Ridge, TN 37831-2561
Phone 615-483-0008/482-4041

In general, all isotopes are shipped by UPS or first class mail. Prices are F.O.B., Oak Ridge, except for radioisotopes coupons, for which there is no shipping cost. The Nucleus does not require any minimum amount for an order, and there is never a handling charge. No return shipments will be accepted without prior notification and authorization.

TENNELEC

LB 5100 Series II

AUTOMATIC LOW BACKGROUND ALPHA/BETA/GAMMA COUNTING SYSTEM

INNOVATION TO MAKE IT FIRST...RELIABILITY TO MAKE IT LAST

TENNELEC LB 5100 SERIES

The TENNELEC LB 5100 Automatic Low Background Alpha/Beta Counting System is an analytical instrument used to determine the gross radiation in low activity samples such as drinking water, air filters and environmental smears.

The ultra low background and high efficiency is achievable only with time proven gas-flow proportional detector technology combined with strict system engineering and manufacturing controls. Specially selected low background materials, electronics designed for long term stability, a sample changer designed for reliable service and human engineered operation are all essential elements in a well engineered system. The resultant performance insures the determination of permissable concentrations for the most stringent of todays trace element regulations.

The TENNELEC LB 5100 has become recognized as an industry standard; a standard for performance and reliability. The LB 5100 Series II adds another dimension to this standard — flexibility. The flexibility to adapt the machine to your specific laboratory routine. The unprecedented computational capability coupled with a user defined reporting format is just one of the flexibility features. In addition automatic plateau generation, CHI square calculations and diagnostic routines provide the tools needed for a rigid Quality Assurance Program.

Ease of operation is an essential feature for any analytical instrument. The LB 5100 Series II has not lost sight of this important fact. Routine operation is as simple as loading the samples and pressing the advance button. The technician need never concern himself with the complexities behind the resulting report.

FIGURE OF MERIT

In comparing the suitability of low background counting systems for a particular application, a relative number called a figure of merit has been used. In essence, the figure of merit expresses the number of samples (not in absolute terms) that can be counted per day to a given statistical accuracy. Regardless of the accuracy chosen, a system with a figure of merit twice that of another system can count twice as many samples in the same amount of time.

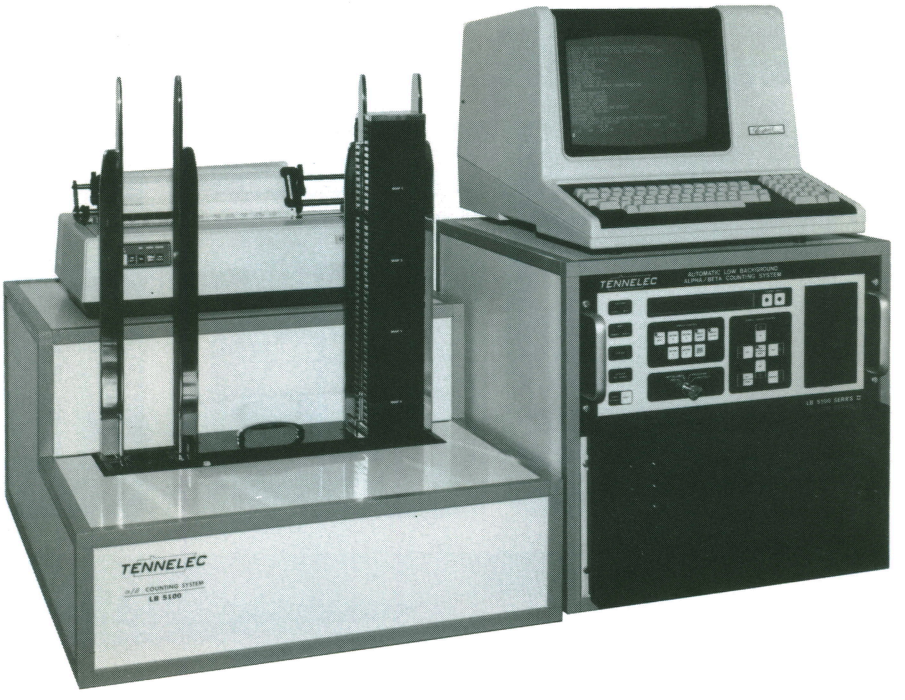
The generally accepted figure of merit for a low background counting system is expressed as the square of the absolute counting efficiency divided by the background count rate. Absolute efficiency is dependent upon counting geometry, absorption factors, intrinsic detector efficiency and detector area relative to the sample area. Background count rates arise from environmental gamma radiation, radiation from material within the system, cosmic radiation and electrical noise.

TENNELEC low background systems exhibit ultra low backgrounds by surrounding the detector with four inches of virgin lead internally lined with OFHC copper. The gas flow proportional counter is constructed from specially selected low background material. A large area cosmic guard detector rejects cosmic shower radiation. Special grounding and interference filters protect the system from electrical noise.

Counting efficiencies are optimized by maintaining less than 4 mm spacing between the sample and detector thus reducing solid angle effects and air absorption. Gas flow detectors with greater than 99% intrinsic efficiency are utilized. Gas flow rather than sealed detectors are recommended because a continuously refreshed gas supply insures that the intrinsic efficiency will not degrade with time due to gas depletion or disassociation. Also only gas flow detectors can be supplied with ultra thin entrance windows which minimize window absorptions. The detector areas are at least 12% greater than the sample area for optimum 2 π counting geometry.

The figure of merit is a measure of a systems gross counting capability. Other factors must also be considered in comparing systems. One such factor is the alpha to beta crosstalk. Systems in current use whether they use gas proportional detectors or scintillation type detectors separate alpha and beta events in simultaneous count modes by energy or pulse height discrimination techniques. Based upon published data, gas flow detectors exhibit superior crosstalk performance. Obviously these measurements are made under controlled conditions. Self absorption effects in the sample increase the difficulties in separating alpha and beta events during simultaneous counting. Here the gas proportional counter has the advantage of being able to reduce crosstalk by counting the sample for alphas only at a reduced bias. The beta contribution may then be calculated from the gross counts obtained in the simultaneous mode.

Other tangible factors in selecting a system are reliability, serviceability, data manipulation capability and convenience features. TENNELEC is proud of its efforts to provide the best in low background counting systems and support. Whatever your requirements or application, it is TENNELEC's goal to be the one company you can depend upon.

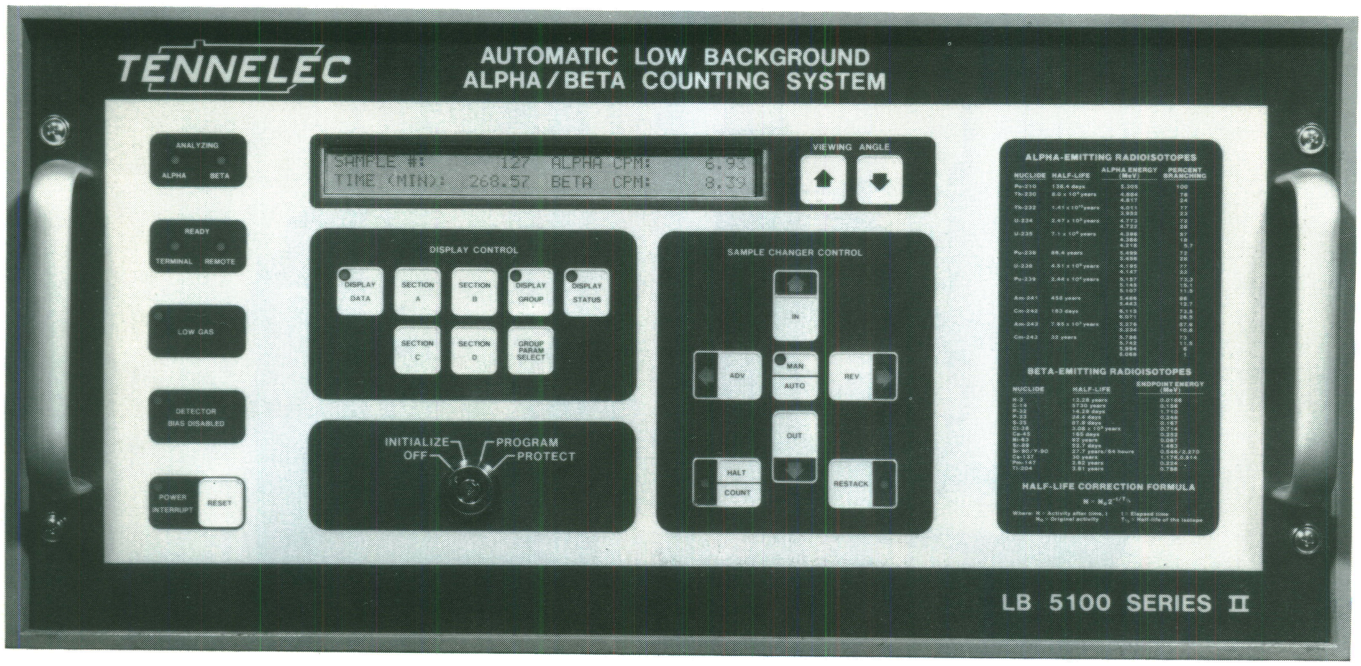


Standard Features of the LB 5100 Series II System:

- 2.25" diameter gas-flow sample detector.
- Ultrathin 80 $\mu gm/cm^2$ detector window.
- 25 square inch gas-flow guard detector.
- Accommodates up to 2" diameter samples.
- Accommodates 50 sample carriers up to 5/16" deep.
- Rapid sample changing.
- Simultaneous or separate low level alpha/beta detection.
- Ultra low background.
- Operates on P-10 gas.
- Two stage gas tank regulator included.
- Flow meter with filter and HV shut off.
- 10 independent sample groups.
- Automatic plateau generation.
- Operator defined report formats.
- Powerful operator accessible mathematics interpreter.
- Operator defined plotting routines.
- Automatic CHI square calculations.
- System diagnostics.
- Easy access detector slide assembly.
- Automatic restart after power interruption.
- 12" diagonal video terminal.
- 120 cps printer with adjustable tractor feed.
- Time of Day/Time of Year Clock with battery back-up.
- Non-volatile memory.
- Dual independent RS-232-C input/output ports.
- Table top cabinets.
- Key-lock protected operation.

Optional Features for the LB 5100 Series II System:

- 1.25" diameter gas-flow sample detector.
- 500 $\mu gm/cm^2$ detector windows.
- Mobile cabinet.
- 100 sample capacity to accommodate 100 sample carriers up to 5/16" deep.
- Separate independent NaI(Tl) gamma detection.
- MCA control synchronization.
- Single or dual drive floppy disk storage.



PROCESSOR/CONTROLLER

The flexibility of the TENNELEC LB 5100 Series II System is due primarily to the sophistication of the LB 5120 Processor/Controller. This sophistication is made possible by microprocessor technology coupled with user friendly firmware. The LB 5120 collects the sample count information from the linear electronics and corrects and reports the data in a predefined manner. User defined formats and operating parameters are stored in memory protected by battery back-up. The front panel features a liquid crystal display, sealed membrane switches, color coded status LEDs, and a tamperproof key-locking switch.

The liquid crystal display allows the operator to examine data and various operating parameters independent of the video display or the printer. Unique viewing angle controls optimize the contrast of the display.

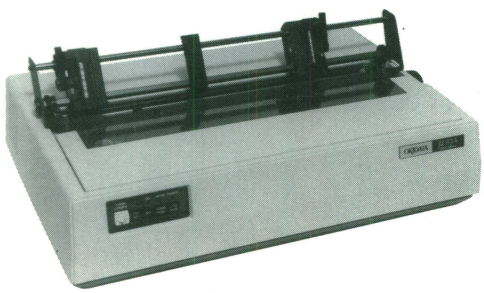
The sealed membrane switches are clustered into display control and sample changer control functions. The display control section selects either data as it is being acquired, sample group parameters (presets, etc.), or changer status (number of changer cycles left, etc.). The sample changer control cluster provides the operator with total manual control of the sample changer.

The LB 5120 front panel contains twelve green status LEDs for an at-a-glance indication of the normal functions of the system. Five red status LEDs are used to indicate conditions which may require operator attention.

Optional single or dual floppy disk drives may replace the radioisotopes table on the front panel. The floppy disk may be used to store sample data as well as user defined operational parameters.

Internally the LB 5120 features non-volatile memory, time-of-day/time-of-year clock with battery back-up, two independent RS-232-C input/output ports and a high voltage control interface. All printed circuit boards are equipped with LEDs which aid in the isolation and diagnostics of problems.

The operator communicates with the system via a video terminal with a standard ASCII keyboard and a large 12 inch diagonal screen. Hard copy is provided via a 120 character per second buffered printer. The printer has selectable character pitch and an adjustable tractor feed mechanism which accommodates paper up to 14" wide.

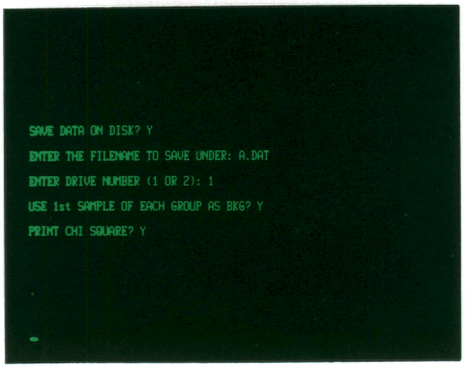


SYSTEM OPERATION

The operation of the LB 5100 Series II is determined by the firmware of the LB 5120 Processor/Controller in conjunction with operator entered parameters. At the executive level a menu of commands can be generated on the screen. These one letter commands will begin a counting sequence, call set-up routines, execute various changer operations or enter one of the utility routines.

Once the LB 5100 set-up has been accomplished, the operation is as simple as loading the samples and telling the system to **Begin** counting. If operation is initiated in this fashion, the operator will be allowed to store data on the optional disks, select the source of the background data, and perform CHI square calculations.

The optional disk will allow raw data such as gross counts, counting time, etc., to be stored on the disk under the file name specified by the operator. This allows the operator to archive the data for future reference. Data in a disk file can be printed

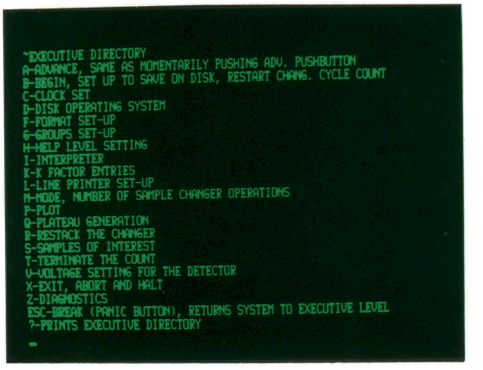


(in any format), plotted or transmitted to a centralized computer system.

Another unique feature of the LB 5100 Series II is the choice of sources for the background count data. The system may be profiled and the resulting background data stored in memory to be used during background subtraction calculations. The operator also has the option of placing a background sample in front of a group of samples and electing to use the data collected from this first sample as the background data.

The LB 5100 can also perform CHI square calculations in conjunction with the averaging mode. The system will recount the sample N number of times (N is entered as a group parameter) and after the last counting interval the CHI square values for the Alpha, Beta and Gamma counts will be calculated and printed. This procedure can be incorporated into a Quality Assurance program by counting a prepared standard to insure that the LB 5100 reproduces the count within statistical limitations.

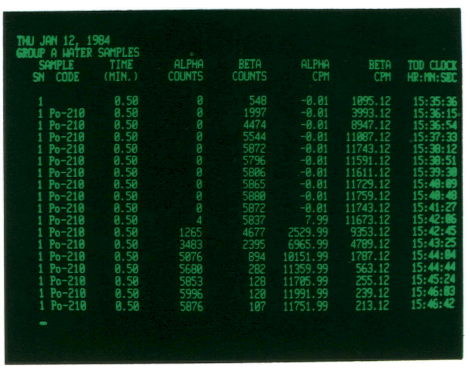
The LB 5100 Series II set-up consists of



establishing the report format, group counting parameters, sample changer operating modes and detector bias settings. Once the set-up has been accomplished the non-volatile memory of the LB 5100 Series II will maintain this information indefinitely. The optional floppy disk storage media also allows any number of set-up conditions to be established and stored for easy retrieval. This permits the system to be shared in a central lab by numerous operators, each with their own unique set-up parameters.

The **Format** specifies the content and structure of the report generated from collected sample data. The format contains the column headers and defines the arithmetics to be performed on data prior to printing. The arithmetics utilizes the powerful LB 5100 interpreter and library of math functions for calculations as simple or as complex as the user requires. The equations are written using a heirarchy similar to many programming languages and variable symbols specific to the LB 5100 (e.g. A=Alpha Counts, B=Beta Counts, T=Time, etc.). In addition to variables set by collected sample data, an array of 256 user defined constants may be incorporated. The values assigned to these constants are defined by the operator. This array can be used to construct weight tables, flow rate information for air samples, etc.

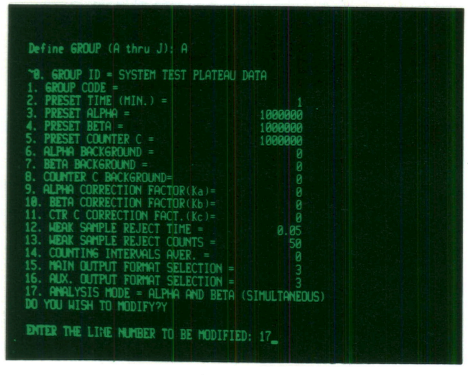
Ten unique formats can be stored in the LB 5100 memory. Four of these formats have been predefined and can be used immediately. The remaining six formats are totally user defined.



THU JAN 12, 1984
GROUP A WATER SAMPLES

SAMPLE SM	CODE	TIME (MIN.)	ALPHA COUNTS	BETA COUNTS	ALPHA CPM	BETA CPM	TOD CLOCK HR:MM:SEC
1		0.50	0	548	-0.01	1095.12	15:35:36
1	Po-210	0.50	0	1997	-0.01	3993.12	15:36:15
1	Po-210	0.50	0	4474	-0.01	8947.12	15:36:54
1	Po-210	0.50	0	5544	-0.01	11087.12	15:37:33
1	Po-210	0.50	0	5872	-0.01	11743.12	15:38:12
1	Po-210	0.50	0	5796	-0.01	11591.12	15:38:51
1	Po-210	0.50	0	5806	-0.01	11611.12	15:39:30
1	Po-210	0.50	0	5865	-0.01	11729.12	15:40:09
1	Po-210	0.50	0	5880	-0.01	11759.12	15:40:48
1	Po-210	0.50	0	5872	-0.01	11743.12	15:41:27
1	Po-210	0.50	4	5837	7.99	11673.12	15:42:06
1	Po-210	0.50	1265	4677	2529.99	9353.12	15:42:45
1	Po-210	0.50	3483	2395	6965.99	4789.12	15:43:25
1	Po-210	0.50	5076	894	10151.99	1787.12	15:44:04
1	Po-210	0.50	5680	282	11359.99	563.12	15:44:44
1	Po-210	0.50	5853	128	11705.99	255.12	15:45:24
1	Po-210	0.50	5996	120	11991.99	239.12	15:46:03
1	Po-210	0.50	5876	107	11751.99	213.12	15:46:42

The LB 5100 Series II comes equipped with ten group plates labeled A through J. These plates are placed in front of a group of samples as they are loaded onto the changer and determine which set of counting parameters are to be used for that group. Any of the parameters can be modified by displaying the **Group** table, entering the line number of the parameter to be modified and then entering the new value. Group tables may also be stored and retrieved from the optional floppy disk.



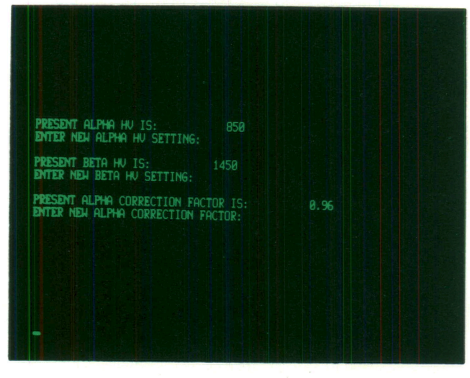
There are a total of eighteen group parameters including a 128 character ID, an 8 character code, presets, backgrounds, correction factors, weak sample reject values and the number of repeat counts before averaging. The latter parameter will allow each sample to be counted and reported the specified number of times and the average for these counts to be computed and reported.

The reporting format for the group is designated by entering the appropriate format number. One of the four standard formats or one of six user defined formats may be specified. Different formats can be selected for simultaneous output to the two output ports. The main output port refers to the terminal and printer while the auxiliary output can be any RS-232-C device (e.g. a remote computer).

One of three analysis modes can be selected for each group of samples: **simultaneous alpha and beta** where the separation of alpha and beta is determined by the pulse height discrimination technique; **alpha only** where the detector is biased at a level where it is sensitive only to alpha particles; or **alpha then beta** where the sample is first counted in the alpha only mode then recounted in the simultaneous mode to determine the contribution of betas. The alpha then beta mode also incorporates an alpha correction factor which is determined and entered by the user. This mode may exhibit less alpha into beta crosstalk than the simultaneous mode for thick samples where self-absorbtion effects are prevalent.

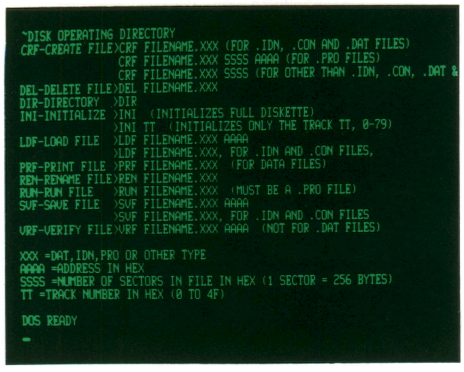
The operator may select the number of times the samples are sequenced through the changer by using the **Mode** command. If a zero is entered, the samples will be counted once and left in the receiving stack. Any other positive integer will cause the changer to sequence and restack the samples to the load position for the specified number of times.

The Detector Bias **Voltage** is controlled by the LB 5120 processor/controller. Two operating bias levels and a plateau correction factor must be entered in order for the system to properly execute the analysis modes. The operating biases are determined by generating detector plateaus using an alpha and a beta source. The alpha only bias level is set on the alpha plateau at a point below the beta sensitivity. The simultaneous (beta) level is set at a point where both the alpha and beta plateaus overlap. The plateau correction factor represents the relative counting efficiency for an alpha standard counted at the alpha only bias level versus the beta bias level. The alpha correction factor is utilized in the alpha then beta analysis mode.

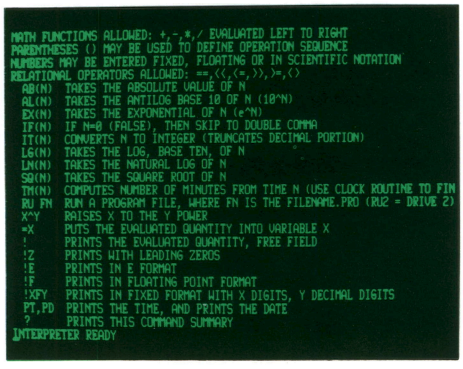


UTILITY ROUTINES

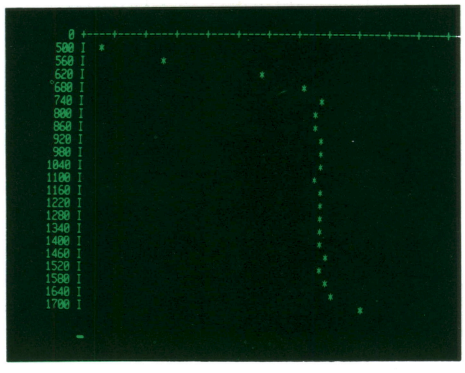
The LB 5100 Series II firmware includes a number of utility routines which complement the general operation of the system. Routines are accessible at the executive level which allow the user to initiate various changer operations from the keyboard such as the advancing and restacking of samples. A **Clock Set** routine is available for setting the time when necessary. A **Line Printer** routine allows the user to set up form-feed operation and select print size for reports. A **Diagnostics** routine allows the operator to run one of several tests which checks for proper switch functions, exercises front-panel LEDs and verifies the system's random access and read only memories. A **Help Level** routine allows the operator to suppress certain menus.



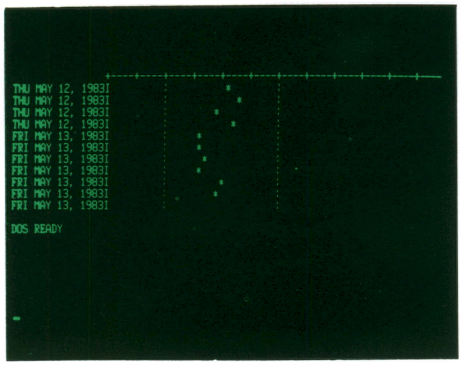
A **Disk Operating System** routine allows the operator to manipulate files on the optional floppy disks. Files can be created, deleted, printed, plotted, etc. by utilizing the various commands of the DOS.



The LB 5100 Series II **Interpreter** can be directly accessed from the keyboard to perform real time calculations in a similar fashion to a calculator. This is the same interpreter accessed by the formatted output routines. The interpreter includes a library of the most frequently used math functions.



A **Plateau Generation** routine allows the operator to automatically produce detector plateaus. Any number of test sources may be loaded and specified along with the starting voltage, ending voltage and voltage increments and the system will collect the plateau data unassisted.



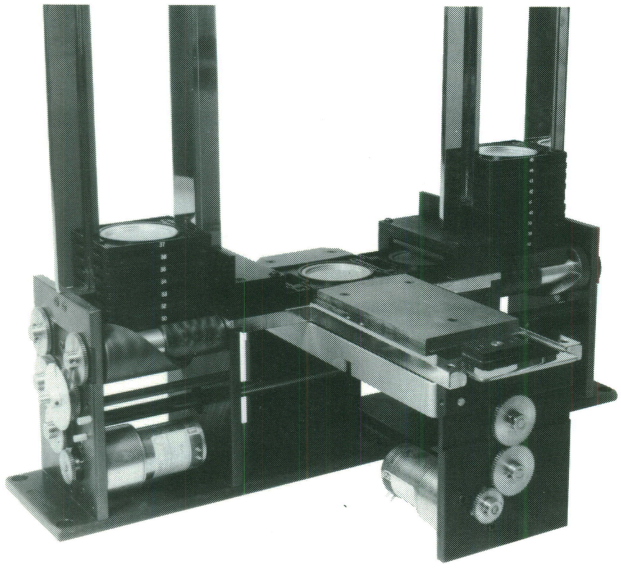
The **Plot** routine is provided to generate graphic representations of data collected from samples and stored in memory or on a disk file. The equations to be used for the plot, number of variables, variable symbols and axis labels are all user defined. The operator can plot detector plateaus, historical background or efficiency performance, etc.

SAMPLE CARRIERS

The LB 5100 uses individually coded carriers to transport the sample to the shielded detector. Each carrier is identified by the pattern of holes along its edge. The carriers may be coded from 1 to 150.

Stainless Steel inserts are provided for each carrier. These inserts are available with inner diameters of either 1-1/16" or 2-1/16". Insert depths are available for 1/16", 1/8", 1/4" or 5/16" deep samples. Samples may be placed directly in the inserts for counting or in standard 1" or 2" diameter planchets.

Each LB 5100 Series II system is supplied with fifty carriers (coded 1 to 50), fifty 2-1/16" x 1/8" inserts and fifty 2-1/16" x 5/16" inserts.



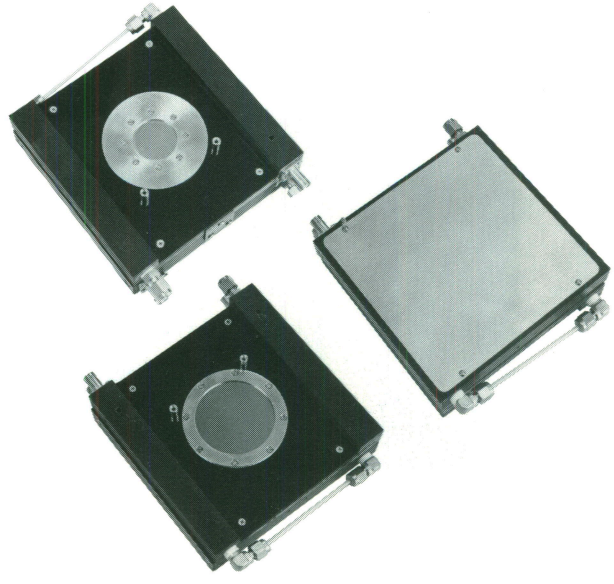
DETECTOR ASSEMBLY

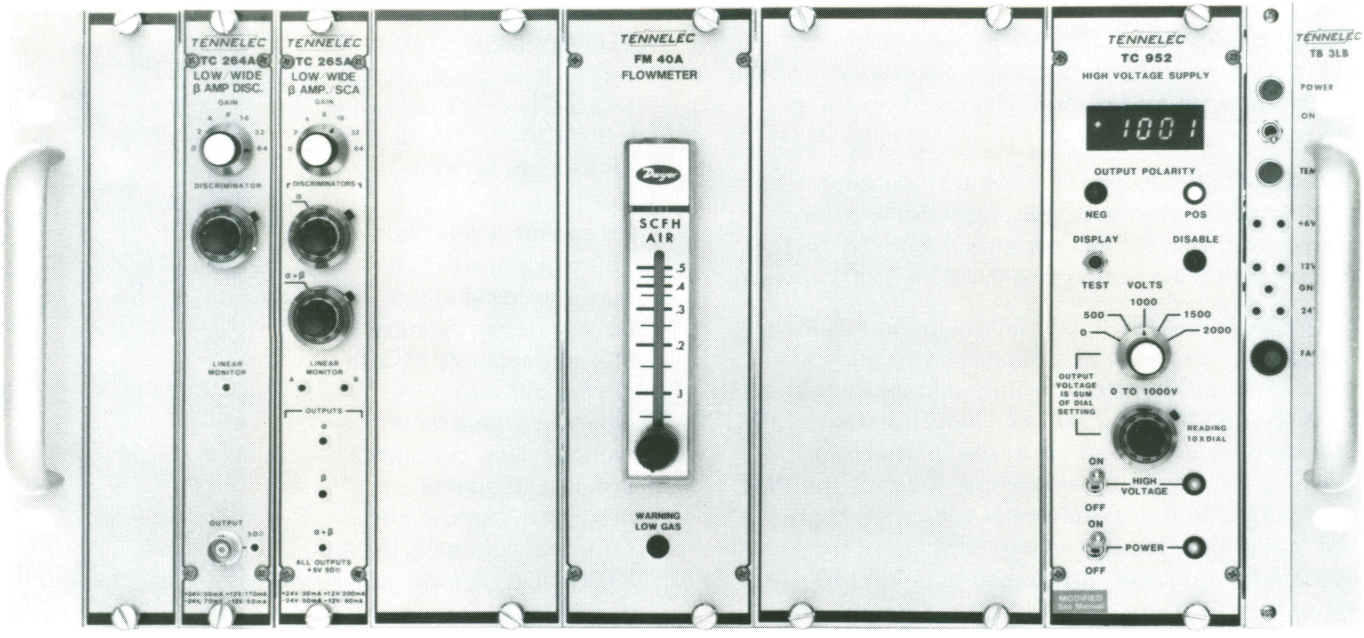
The LB 5100 Detector Assembly consists of two "pancake" type gas flow proportional counters stacked on top of each other. The upper guard detector senses high energy cosmic radiation while the lower detector analyzes alpha and beta radiation emitted from the sample below. The sample detector is standardly 2.25" diameter with an 80 $\mu gm/cm^2$ window. 1.25" diameter detectors and 500 $\mu gm/cm^2$ windows are also available. The entire detector assembly is mounted in a slide assembly for easy access and cleaning, enclosed within oxygen-free high conductivity (OFHC) copper and surrounded by four inches of low background virgin lead. The lead is a very effective shield for gamma and low energy "soft" cosmic rays. The OFHC copper efficiently absorbs lead x-rays produced inside the shield and thus provides an ultra low background condition for sample analysis.

SAMPLE CHANGER

The Sample Changer assembly will accommodate 50 samples standardly or 100 samples optionally (LBA-03 Option). It is microprocessor controlled and employs the fewest possible number of moving parts to insure low wear and high reliability. The basic mechanism consists of three lead screws, gear driven by dc motors. Two parallel lead screws move the sample to a center position in line with and between the input and output sample stacks. A third lead screw then moves the sample perpendicular to the initial motion away from the mechanism and into position under the detector. The typical time required to change samples is from five to seven seconds.

All moving components are protected from damage due to binding by an automatic power interrupt of the drive motors. In the event of a jam, an audible signal and message alerts the operator. Teflon guides in the detector slide assembly assure accurate and repeatable sample positioning for optimum geometric efficiency. The sample changer is either manually controlled by pushbuttons or automatically controlled by the system processor.





SYSTEM LINEAR ELECTRONCIS

The linear signal processing electronics for the LB 5100 Series II System are modular and powered by a standard TENNELEC NIM Bin. This modular approach carries with it many years of reliability and proven performance and allows the user to conveniently isolate a problem should the system ever fail to perform properly. Replacement modules can be sent by mail to quickly return the system to operation.

NIM BIN AND POWER SUPPLY provides the proper voltages necessary for the operation of the modular electronics. Built into this instrument are:

* Power "on" and temperature "warning" indicator lights
* Line voltage filter
* Voltage monitoring test points
* Power "interrupt" indicator light
* Spare slots for future expansion or options

PREAMPLIFIERS designed for low noise proportional counters distribute high voltage to their respective detector and amplify the charge input signal for transmission to the appropriate NIM amplifier.

GUARD AMPLIFIER/DISCRIMINATOR Amplifies the pulses from the guard detector preamplifier and generates a blocking pulse for each input signal that exceeds the adjustable discriminator.

SAMPLE AMPLIFIER/DUAL DISCRIMINATOR Amplifies the pulses from the sample detector preamplifier. Two discriminators are set to separate alpha and beta events in the simultaneous analysis mode. One is set above noise but below typical beta energies while the second is set above beta and below alpha energies. A wide beta feature is incorporated which expands the beta response thus enabling the system to better discriminate between low energy betas and noise. If both levels are exceeded, an output is generated indicating the detection of an alpha while if only the lower level is exceeded, an output is generated indicating the detection of a beta. All pulses are routed to the Processor/Controller for acceptance or rejection by a guard detector blocking pulse.

FLOW METER is provided adjusting the flow of P-10 gas to both detectors. The meter is calibrated in standard cubic feet per hour (SCFH) of air over the range 0.00 to 0.40 in increments of 0.05 SCFH. The flow meter has a replacable filter for contaminent removal. A built-in gas pressure sensor and circuitry is also included to indicate low gas pressure and disable the detector bias voltage. A two stage gas tank regulator is also provided and fits all standard gas tanks.

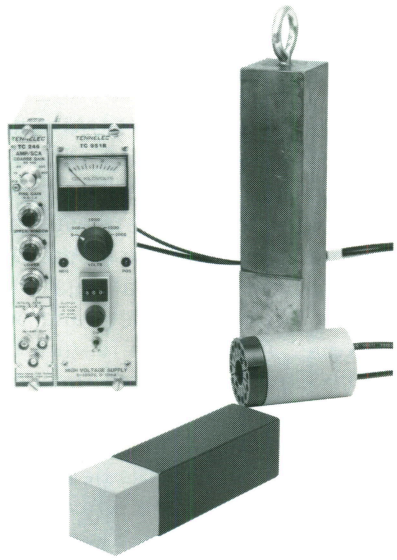
DETECTOR BIAS SUPPLY Provides the regulated high voltage to both detectors via independent outputs routed through the preamplifiers. The bias supply is remotely controlled by the System Processor/Controller.

OPTIONAL EQUIPMENT AND ACCESSORIES

MOBILE CABINET (LBA-01) Rugged compact cabinet on wheels with collapsible shelves for the video terminal and printer. (Pictured on front cover).

100 SAMPLE CAPACITY (LBA-03) Includes 100 sample capacity stacks, 50 additional carriers coded 51 thru 100, 50 additional 2-1/16" x 1/8" inserts and 50 additional 2-1/16" x 5/16" inserts.

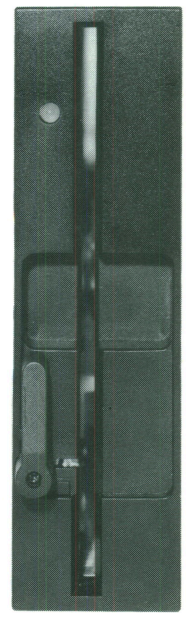
GAMMA COUNTER (LBA-07) Includes a NaI(Tl) detector and electronics necessary to add simultaneous gamma counting capability to the LB 5100 Series II. The 2"x2"x2" NaI(Tl) detector, PMT and preamp are mounted in the lead shield viewing the sample from below. Bias for the PMT is provided from an additional regulated High Voltage supply located in the NIM Bin. The detected signals are processed by a TC 246 Amplifier/SCA and routed to the System Processor/Controller for collection. The TC 246 linear output signal can be connected to a MCA to generate a gamma spectrum. A lead plug is provided to seal the shield in case the gamma detector is removed. (Alpha/beta background may increase slightly with the gamma detector installed.)



MCA SYNCHRONIZATION (LBA-08) This option provides three signals which can synchronize a MCA (used to collect a gamma spectrum in conjunction with the gamma detector option) to the operation of LB 5100.

MCA READY	Input signal from the MCA which indicates that the MCA is in the acquire mode if signal is a TTL high level.
LB 5100 READY	Output signal from the Processor/Controller with a TTL high level indicating the LB 5100 has sample in position and is ready to count.
PRESET TIME	A low going TTL compatible pulse (nominally 5 μsec wide) indicating that the LB 5100 counting timer has timed out.

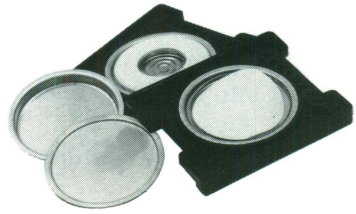
FLOPPY DISK STORAGE Either a single drive (LB 5120-01) or a dual drive (LB 5120-02) floppy disk option can be mounted in the System Processor/Controller. The disks are 5-1/4" diameter dual sided, double density with a storage capacity of 368 kbytes per disk. Operating parameters, sample data, constants tables and special programs can be stored on the disks using the LB 5100 DOS. A single diskette can hold the raw data from over 5700 samples.



CARRIERS Additional BCD coded sample carriers are available in lots of 50 each coded:

1 - 50	P/N 6200-0096
51 - 100	P/N 6200-0097
101 - 150	P/N 6200-0088

CARRIER INSERTS Additional stainless steel inserts are available in depths of 1/16", 1/8" 1/4" or 5/16". These inserts are available for either 1" or 2" planchets. Refer to the TENNELEC SYSTEMS PRICE LIST for part numbers and prices.



CARRIER CASSETTE (P/N 1750-0023) Capable of holding 50 carriers these cassettes are very useful when samples must be transported from a preparation lab to be loaded onto the LB 5100 System.

DETECTOR WINDOWS Sample detector windows may be replaced if they are ruptured or become contaminated. Windows are available in four sizes.

2.25" diameter -	80 μgm/cm^2	P/N 6200-0038
	500 μgm/cm^2	P/N 6200-0037
1.25" diameter -	80 μgm/cm^2	P/N 6200-0036
	500 μgm/cm^2	P/N 6200-0035

SYSTEM PERFORMANCE

USING P-10 (90% Argon, 10% Methane) GAS

DETECTOR BACKGROUND

2.25" Detector: ≤1.3 cpm alpha plus beta (standard)
typical alpha = 0.05 cpm
typical beta = 0.80 cpm

1.25" Detector: ≤0.5 cpm alpha plus beta (optional)
typical alpha = 0.03 cpm
typical beta = 0.30 cpm

(Measured with TENNELEC specified gas in Oak Ridge, Tennessee)

DETECTOR EFFICIENCY

With 80 $\mu gm/cm^2$ window (standard)
≥30% of ^{14}C
≥45% for ^{90}Sr - ^{90}Y
≥40% for ^{210}Po

With 500 $\mu gm/cm^2$ window (optional)
≥20% for ^{14}C
≥40% for ^{90}Sr - ^{90}Y
≥35% for ^{210}Po

ALPHA-BETA CROSSTALK (Simultaneous mode)

For a typical 2.25" detector with an 80 $\mu gm/cm^2$ window counting ^{210}Po and ^{90}Sr, with ^{90}Sr adjusted for maximum efficiency and 1% crosstalk into the alpha channel, there will be a ≤3% crosstalk for ^{210}Po into the beta channel.

DETECTOR PLATEAUS

^{210}Po: ≤1.5% slope/100V; ≥800V plateau
^{90}Sr: ≤2.5% slope/100V; ≥200V plateau

DETECTOR UNIFORMITY

± 5% over 90% of window

GUARD DETECTOR EFFICIENCY

≥99% cosmic detection

SAMPLE COUNT RATE

500,000 cpm with <1.5% dead-time loss

SAMPLE CHANGER CAPACITY

50 samples standard or 100 samples optional

SAMPLE CHANGEOVER TIME

Typically 5 seconds to remove one sample and replace with the next.

TIMEBASE ACCURACY

0.002% crystal timebase

COUNTING TIME

Counting time per sample can be set at any number between 0.01 minutes and 1,000,000.00 minutes.

COUNT CAPACITY

Alpha, beta and gamma counters have a capacity of 10^{10} counts with 9 significant digits.

PRESET

In addition to being able to preset time per sample, independent preset counts may be entered for either alphas, betas, or gammas. Weak sample count reject is also available.

GAMMA COUNTING CHANNEL (LBA-07 Option)

Background: 125 cpm typical for 0.2 to 2.0 MeV window
Resolution: ≤ 8.5% measured with ^{137}Cs

ORDERING INFORMATION

SIZE AND WEIGHT

Electronics Cabinet
20.75"L x 20.75"W x 19.5"H; 83 lbs
52.7 cm x 52.7 cm x 49.5 cm; 37.7 kg

Sample Changer
35.0"L x 26.0"W x 30.0"H; 1430 lbs
88.9 cm x 66.0 cm x 76.2 cm; 648.7 kg

Video Terminal
21.7"L x 17.5"W x 13.4"H; 30 lbs
55.0 cm x 44.5 cm x 34.0 cm; 13.5 kg

Printer
12.9"L x 20.2"W x 5.2"H; 30.9 lbs
32.8 cm x 51.2 cm x 13.3 cm; 13.9 kg

Total System Shipping Weight
1838 lbs; 833.7 kg

POWER

117V ± 10%, 60 Hz ± 3%; ~ 2.50 amps
or 230V ± 10%, 50 Hz ± 3%; ~ 1.25 amps

ENVIRONMENT

Operating temperature 10-40°C (50-104°F)
Relative humidity 20% to 90% non-condensing

WARRANTY

One year except video terminal and printer (90 day)

MANUALS

One complete set of operators and maintenance manuals provided with each system ordered.

(Specifications subject to change without notice)

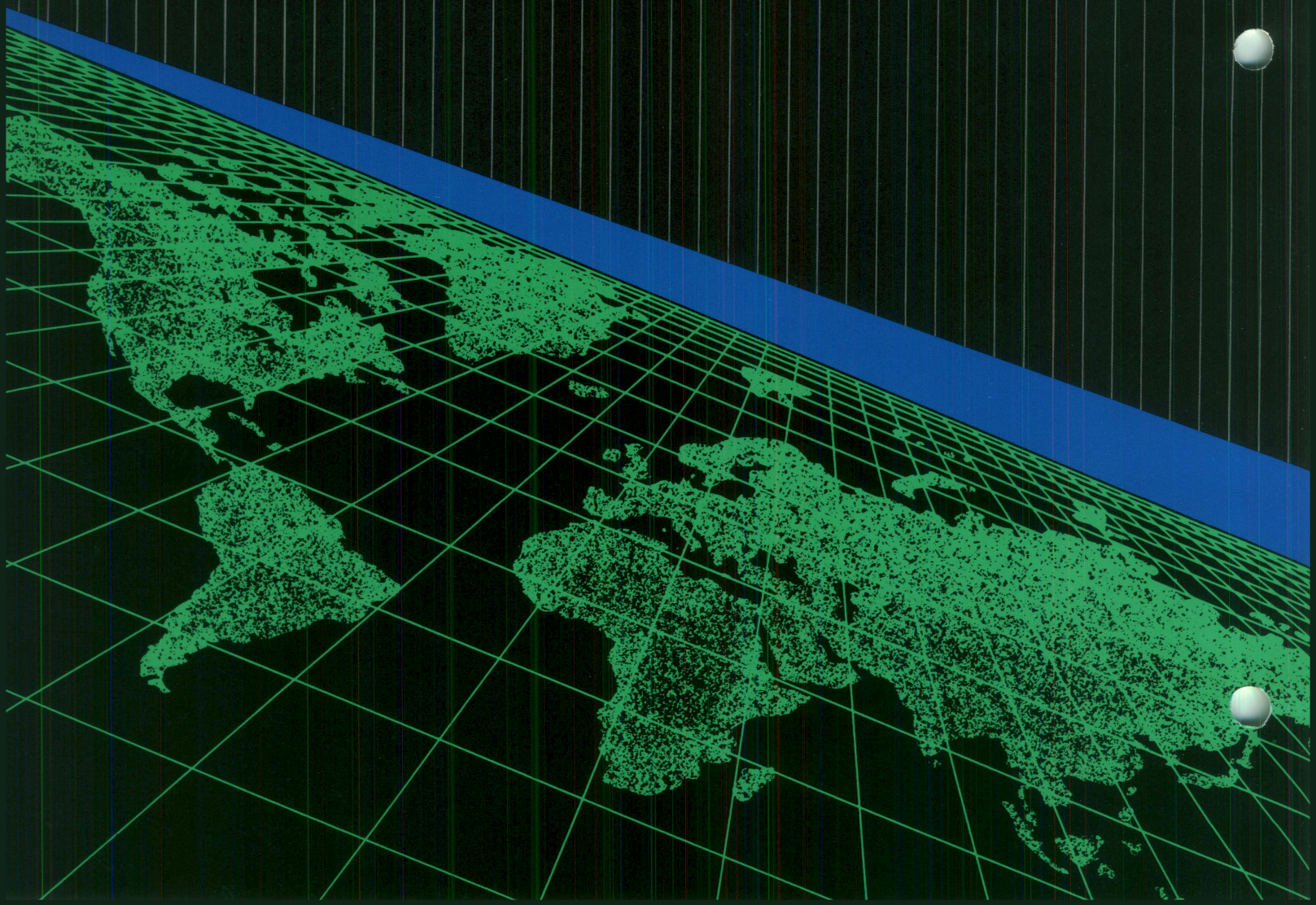
LB 5100 SERIES II 10.0K 186

TENNELEC, Inc.
601 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830-2560
USA

Telephone (615) 483-8405
TWX 810-572-1018

TENNELEC, GmbH
Münchner Strasse 50
D 8025 Unterhaching
WEST GERMANY

Telephone 089/611-5060
TLX 5215959 FRIE D



TENNELEC

LB 5100-PW

AUTOMATIC PHOSWICH LOW BACKGROUND ALPHA/BETA/GAMMA COUNTING SYSTEM

INNOVATION TO MAKE IT FIRST...RELIABILITY TO MAKE IT LAST

TENNELEC LB 5100

The TENNELEC LB 5100 Automatic Low Background Alpha/Beta Counting System is an analytical instrument used to determine the gross radiation in low activity samples such as drinking water, air filters and environmental smears.

The TENNELEC LB 5100 Series of alpha/beta counting systems has become recognized as an industry standard for performance and reliability. The utlimate in performance for these systems is still best realized by one of the oldest in nuclear detector technology; gas-flow proportional counters. These detectors still offer the best in efficiency, cross-talk and background performance. The price one pays for this performance is the inconvenience of maintaining a supply of P-10 counting gas. In many applications this is not practical or desirable and for this reason TENNELEC has expanded the LB 5100 Series integrating the Phoswich detector and introducing the LB 5100-PW Automatic Low Background Alpha/Beta/Gamma Counting System.

The LB 5100-PW System combines the convenience of no-gas operation with the most reliable and flexible sample changer and data reporting system commercially available. Samples are presented to the shielded detector in individually coded carriers capable of holding 2 inch planchets from 1/16" to 5/16" deep. Standard capacity is 50 samples with the option of expanding to 100 samples. The linear processing electronics is all NIM modular for ease of calibration and service. Alpha, Beta and Gamma data is collected by the LB 5120 Processor/Controller. The data collection parameters and reporting formats are determined by the operator in conjunction with the microprocessor based LB 5120. The operator communicates to the LB 5120 through a large screen video terminal. Printed reports are generated on a buffered, 120 character per second printer. The printer features a tractor feed mechanism which will accept paper up to 14 inches wide.

THE PHOSWICH DETECTOR

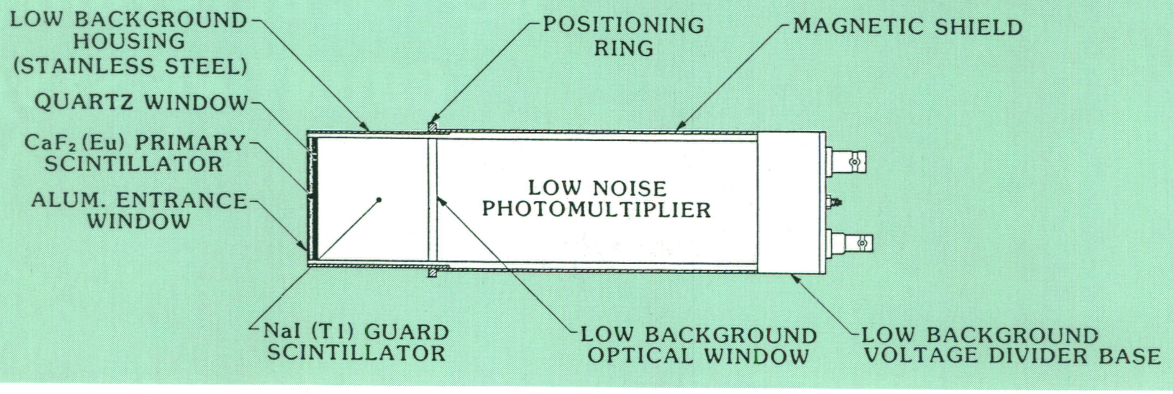
The phoswich detector is a sandwich of two scintillation phosphors with distinctly different decay times. Events occurring in the two phosphors can be separated using a pulse shape analysis technique. It is this characteristic which makes the phoswich detector useful in low background counting applications. While there are many different types, the phoswich detector utilized in Tennelec alpha/beta/gamma counting systems is composed of a calcium fluoride [CaF_2(Eu)] crystal and a sodium iodide [NaI(Tl)] crystal separated by a quartz dead layer and optically coupled to a photomultiplier tube.

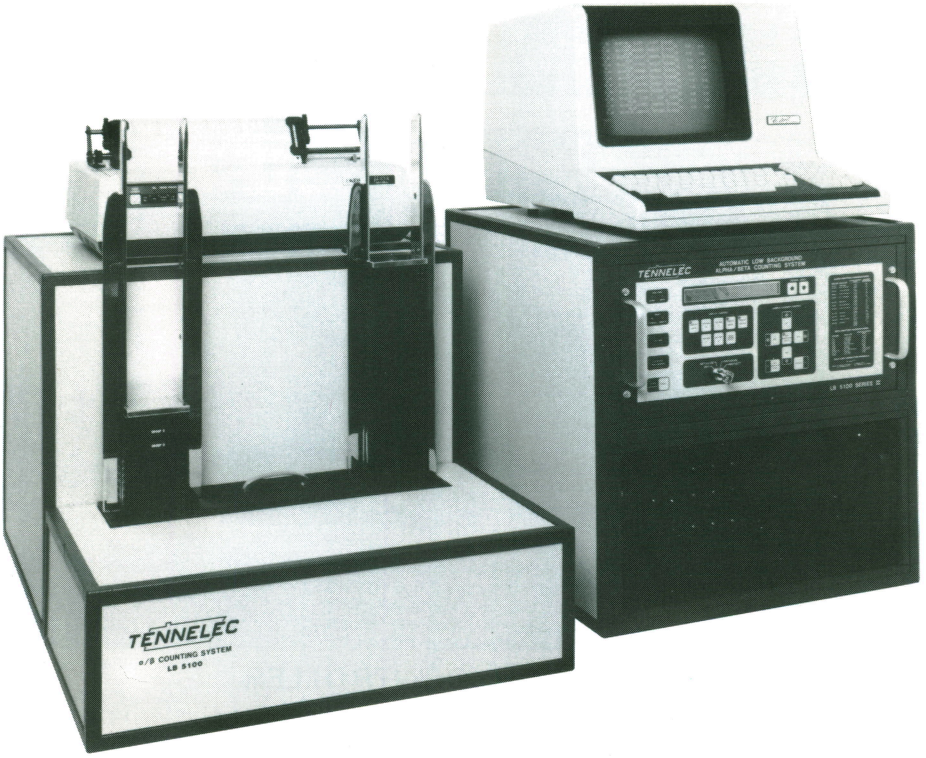
The primary scintillator is the thin CaF_2(Eu) crystal. Alpha particles are totally absorbed by this crystal. Beta particles deposit part of their energy (depending on the angle of incidence) in the CaF_2(Eu) and the remainder in the quartz dead layer. The absorbed energy in the CaF_2(Eu) crystal decays by photon emission with approximately a 0.9 microsecond decay time constant.

Gamma and cosmic radiation is absorbed either totally or partially by the NaI(Tl) crystal. This absorbed energy decays by photon emission with a 0.23 microsecond decay time constant.

The front surface of the phoswich detector is protected by a few hundred angstroms of deposited aluminum. This coating serves two purposes other than protection. Firstly the aluminized coating helps to prevent external light from entering the detector. Secondly the reflective surface prevents internally generated photons from exiting the front surface of the detector.

Photons from the two scintillators are collected by a common photomultiplier tube (PMT) and converted into a voltage pulse. The leading edge of the pulse characterizes the scintillator from which the photons originated. This pulse is linearly amplified and processed by a pulse shape analyzer which separates the alpha/beta pulses from the gamma or cosmic pulses. The pulses can now be further processed by a pulse height analyzer to separate the alphas from the betas and the gammas from the cosmics. After the pulses have been characterized, they can be routed to the appropriate counters for data collection.



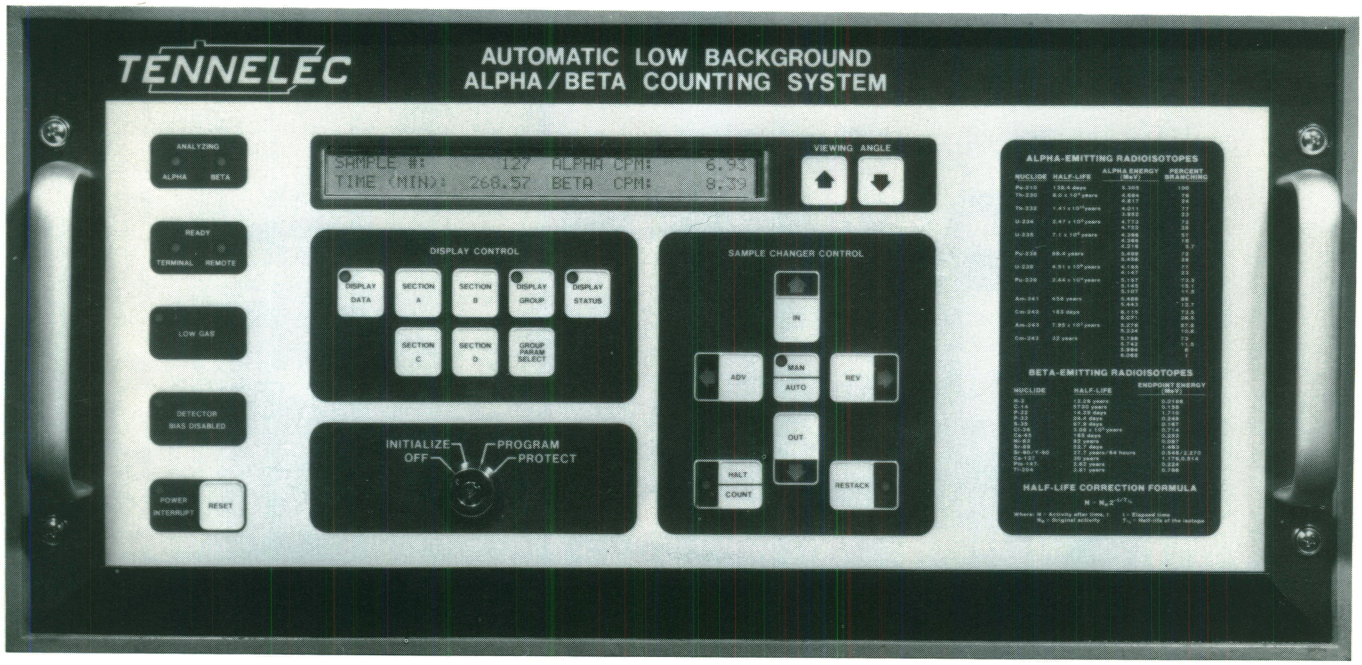


Standard Features of the LB 5100-PW System:

- 2.0" diameter phoswich detector.
- Accommodates up to 2" diameter samples.
- Accommodates 50 sample carriers up to 5/16" deep.
- Rapid sample changing.
- Simultaneous low level alpha/beta/gamma detection.
- Ultra low background.
- 10 independent sample groups.
- Operator defined report formats.
- Powerful operator accessible mathematics interpreter.
- Operator defined plotting routines.
- Automatic CHI square calculations.
- System diagnostics.
- Easy access detector slide assembly.
- Automatic restart after power interruption.
- 12" diagonal video terminal.
- 120 cps printer with adjustable tractor feed.
- Time of Day/Time of Year Clock with battery back-up.
- Non-volatile memory.
- Dual independent RS-232-C input/output ports.
- Table top cabinets.
- Key-lock protected operation.

Optional Features for the LB 5100-PW System:

- Mobile cabinet.
- 100 sample capacity to accommodate 100 sample carriers up to 5/16" deep.
- MCA control synchronization.
- Single or dual drive floppy disk storage.



PROCESSOR/CONTROLLER

The flexibility of the TENNELEC LB 5100-PW System is due primarily to the sophistication of the LB 5120 Processor/Controller. This sophistication is made possible by microprocessor technology coupled with user friendly firmware. The LB 5120 sends and receives signals which identify the samples and advance them into counting position underneath the detector. The LB 5120 then collects the sample count information from the linear electronics and corrects and reports the data in a predefined manner. User defined formats and operating parameters are stored in memory protected by battery back-up. The front panel features a liquid crystal display, sealed membrane switches, color coded status LEDs, and a tamperproof key-locking switch.

The liquid crystal display allows the operator to examine data and various operating parameters independent of the video display or the printer. Unique viewing angle controls optimize the contrast of the display.

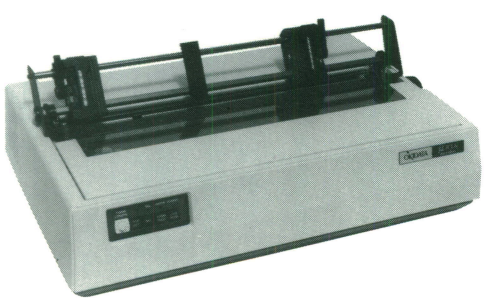
The sealed membrane switches are clustered into display control and sample changer control functions. The display control section selects either data as it is being acquired, sample group parameters (presets, etc.), or changer status (number of changer cycles left, etc.). The sample changer control cluster provides the operator with total manual control of the sample changer.

The LB 5120 front panel contains twelve green status LEDs for an at-a-glance indication of the normal functions of the system. Five red status LEDs are used to indicate conditions which may require operator attention.

Optional single or dual floppy disk drives may replace the radioisotopes table on the front panel. The floppy disk may be used to store sample data as well as user defined operational parameters.

Internally the LB 5120 features non-volatile memory, time-of-day/time-of-year clock with battery back-up, two independent RS-232-C input/output ports and a high voltage control interface. All printed circuit boards are equipped with LEDs which aid in the isolation and diagnostics of problems.

The operator communicates with the system via a video terminal with a standard ASCII keyboard and a large 12 inch diagonal screen. Hard copy is provided via a 120 character per second buffered printer. The printer has selectable character pitch and an adjustable tractor feed mechanism which accommodates paper up to 14" wide.

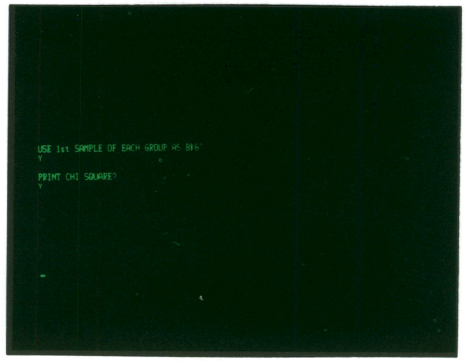


SYSTEM OPERATION

The operation of the LB 5100-PW is determined by the firmware of the LB 5120 Processor/Controller in conjunction with operator entered parameters. At the executive level a menu of commands can be generated on the screen. These one letter commands will begin a counting sequence, call set-up routines, execute various changer operations or enter one of the utility routines.

Once the LB 5100 set-up has been accomplished, the operation is as simple as loading the samples and telling the system to **Begin** counting. If operation is initiated in this fashion, the operator will be allowed to store data on the optional disks, select the source of the background data, and perform CHI square calculations.

The optional disk will allow raw data such as gross counts, counting time, etc., to be stored on the disk under the file name specified by the operator. This allows the operator to archive the data for future reference. Data in a disk file can be printed

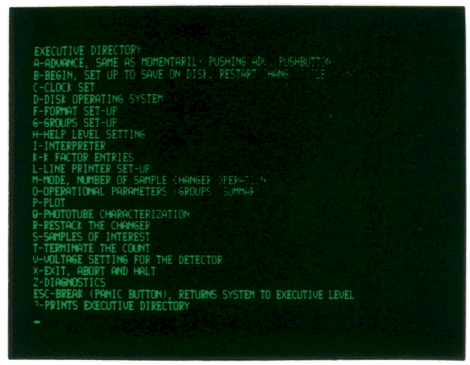


(in any format), plotted or transmitted to an external computer system.

Another unique feature of the LB 5100-PW is the choice of sources for the background count data. The system may be profiled and the resulting background data stored in memory to be used during background subtraction calculations. The operator also has the option of placing a background sample in front of a group of samples and electing to use the data collected from this first sample as the background data.

The LB 5100 can also perform CHI square calculations in conjunction with the averaging mode. The system will recount the sample N number of times (N is entered as a group parameter) and after the last counting interval the CHI square values for the Alpha, Beta and Gamma counts will be calculated and printed. This procedure can be incorporated into a Quality Assurance program by counting a prepared standard to insure that the LB 5100 reproduces the count within statistical limitations.

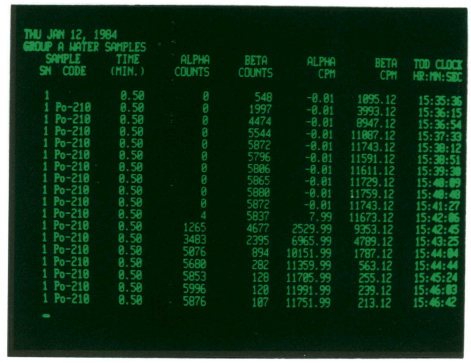
The LB 5100-PW set-up consists of establishing



the report format, group counting parameters, sample changer operating modes and detector bias settings. Once the set-up has been accomplished the non-volatile memory of the LB 5100-PW will maintain this information indefinitely. The optional floppy disk storage media also allows any number of set-up conditions to be established and stored for easy retrieval. This permits the system to be shared in a central lab by numerous operators, each with their own unique set-up parameters.

The **Format** specifies the content and structure of the report generated from collected sample data. The format contains the column headers and defines the arithmetics to be performed on data prior to printing. The arithmetics utilizes the powerful LB 5100 interpreter and library of math functions for calculations as simple or as complex as the user requires. The equations are written using a heirarchy similar to many programming languages and variable symbols specific to the LB 5100 (e.g. A=Alpha Counts, B=Beta Counts, T=Time, etc.). In addition to variables set by collected sample data, an array of 256 user defined constants (K (n) where n=o to 255) may be incorporated. The values assigned to these constants are defined by the operator. This array can be used to construct weight tables, flow rate information for air samples, etc.

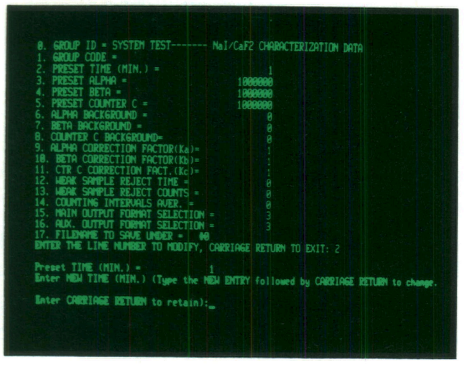
Ten unique formats can be stored in the LB 5100 memory. Four of these formats have been predefined and can be used immediately. The remaining six formats are totally user defined.



THU JAN 12, 1984
GROUP A WATER SAMPLES

SAMPLE SN	CODE	TIME (MIN.)	ALPHA COUNTS	BETA COUNTS	ALPHA CPM	BETA CPM	TOD CLOCK HR:MN:SEC
1		0.50	0	548	-0.01	1095.12	15:35:36
1	Po-210	0.50	0	1997	-0.01	3993.12	15:36:15
1	Po-210	0.50	0	4474	-0.01	8947.12	15:36:54
1	Po-210	0.50	0	5544	-0.01	11087.12	15:37:33
1	Po-210	0.50	0	5872	-0.01	11743.12	15:38:12
1	Po-210	0.50	0	5796	-0.01	11591.12	15:38:51
1	Po-210	0.50	0	5806	-0.01	11611.12	15:39:30
1	Po-210	0.50	0	5865	-0.01	11729.12	15:40:09
1	Po-210	0.50	0	5880	-0.01	11759.12	15:40:48
1	Po-210	0.50	0	5872	-0.01	11743.12	15:41:27
1	Po-210	0.50	4	5837	7.99	11673.12	15:42:06
1	Po-210	0.50	1265	4677	2529.99	9353.12	15:42:45
1	Po-210	0.50	3483	2395	6965.99	4789.12	15:43:25
1	Po-210	0.50	5076	894	10151.99	1787.12	15:44:04
1	Po-210	0.50	5680	282	11359.99	563.12	15:44:44
1	Po-210	0.50	5853	128	11705.99	255.12	15:45:24
1	Po-210	0.50	5996	120	11991.99	239.12	15:46:03
1	Po-210	0.50	5876	107	11751.99	213.12	15:46:42

The LB 5100-PW comes equipped with ten group plates labeled A through J. These plates are placed in front of a group of samples as they are loaded onto the changer and determine which set of counting parameters are to be used for that group. Any of the parameters can be modified by displaying the **Group** table, entering the line number of the parameter to be modified and then entering the new value. Group tables may also be stored and retrieved from the optional floppy disk.



There are a total of eighteen group parameters including a 128 character ID, an 8 character code, presets, backgrounds, correction factors, weak sample reject values and the number of repeat counts before averaging. The latter parameter will allow each sample to be counted and reported the specified number of times and the average for these counts to be computed and reported.

The reporting format for the group is designated by entering the appropriate format number. One of the four standard formats or one of six user defined formats may be specified. Different formats can be selected for simultaneous output to the two output ports. The main output port refers to the terminal and printer while the auxiliary output can be any RS-232-C device (e.g. a remote computer).

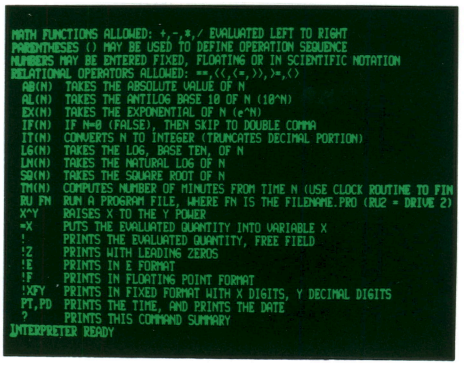
The operator may select the number of times the samples are sequenced through the changer by using the **Mode** command. If a zero is entered, the samples will be counted once and left in the receiving stack. Any other positive integer will cause the changer to sequence and restack the samples to the load position for the specified number of times.

UTILITY ROUTINES

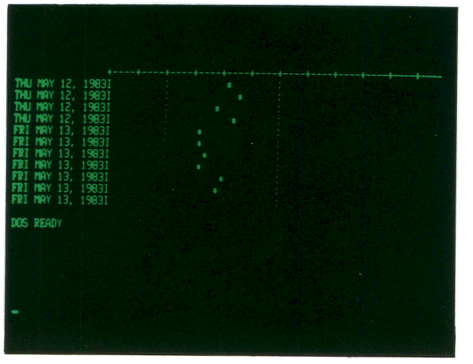
The LB 5100-PW firmware includes a number of utility routines which complement the general operation of the system. Routines are accessible at the executive level which allow the user to initiate various changer operations from the keyboard such as the advancing and restacking of samples. A **Clock Set** routine is available for setting the time when necessary. A **Line Printer** routine allows the user to set up form-feed operation and select print size for reports. A **Diagnostics** routine allows the operator to run one of several tests which checks for proper switch functions, exercises front-panel LEDs and verifies the system's random access and read only memories. A **Help Level** routine allows the operator to suppress certain menus.

A **Phototube Characterization** routine allows the operator to automatically generate and/or check discriminator settings to optimize cross-talk performance and to plot results on the Video Terminal or Printer. Standards can be loaded in the system with brief instructions and the LB 5100-PW System will, without further attention, run and plot the cross-talk performance.

A **Disk Operating System** routine allows the operator to manipulate files on the optional floppy disks. Files can be created, deleted, printed, plotted, etc. by utilizing the various commands of the DOS.



The LB 5100-PW **Interpreter** can be directly accessed from the keyboard to perform real time calculations in a similar fashion to a calculator. This is the same interpreter accessed by the formatted output routines. The interpreter includes a library of the most frequently used math functions.



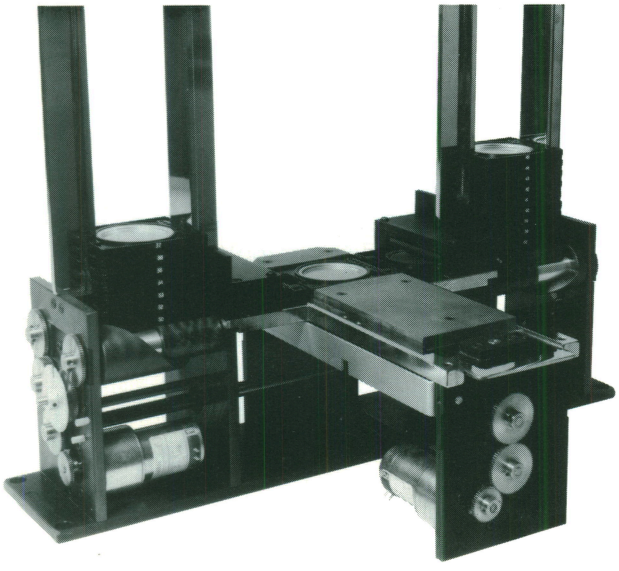
The **Plot** routine is provided to generate graphic representations of data collected from samples and stored in memory or a disk file. The equations to be used for the plot, number of variables, variable symbols and axis labels are all user defined. The operator can plot historical background or efficiency performance, etc.

SAMPLE CARRIERS

The LB 5100 uses individually coded carriers to transport the sample to the shielded detector. Each carrier is identified by the pattern of holes along its edge. The carriers may be coded from 1 to 150.

Stainless Steel inserts are provided for each carrier. These inserts are available with inner diameters of either 1-1/16" or 2-1/16". Insert depths are available for 1/16", 1/8", 1/4" or 5/16" deep samples. Samples may be placed directly in the inserts for counting or in standard 1" or 2" diameter planchets.

Each LB 5100-PW system is supplied with fifty carriers (coded 1 to 50), fifty 2-1/16" x 1/8" inserts and fifty 2-1/16" x 5/16" inserts.



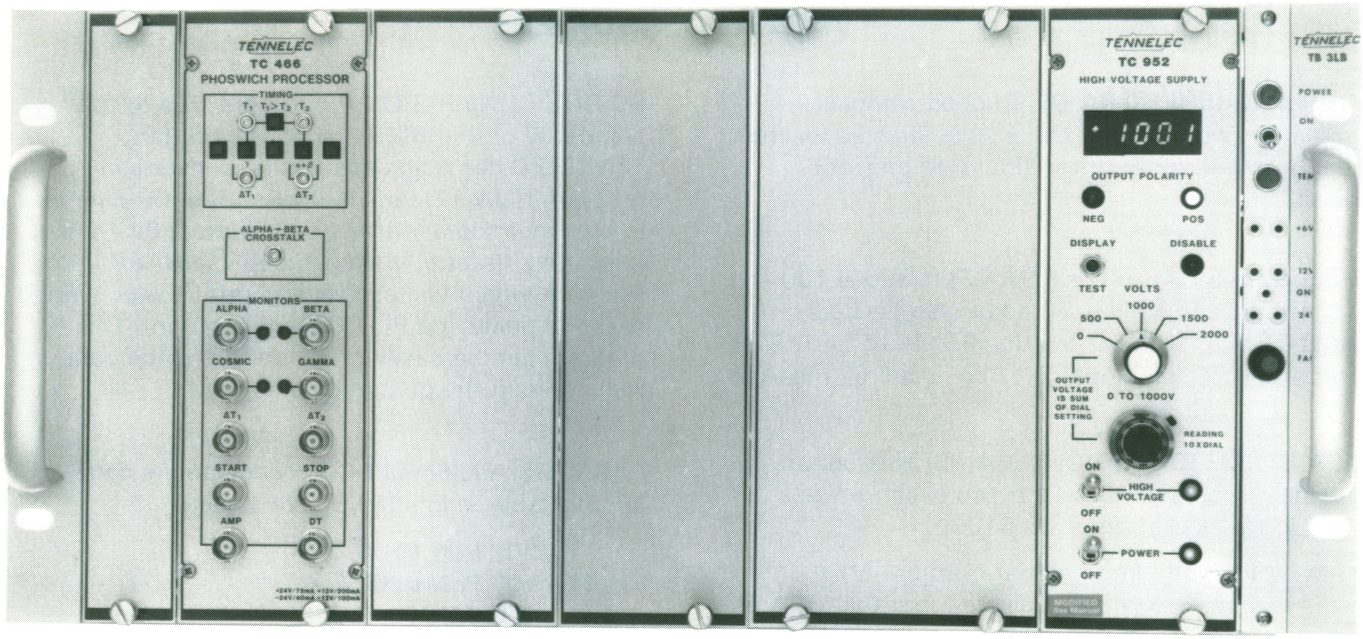
SAMPLE CHANGER

The Sample Changer assembly will accommodate 50 samples standardly or 100 samples optionally (LBA-03 Option). It is microprocessor controlled and employs the fewest possible number of moving parts to insure low wear and high reliability. The basic mechanism consists of three lead screws, gear driven by dc motors. Two parallel lead screws move the sample to a center position in line with and between the input and output sample stacks. A third lead screw then moves the sample perpendicular to the initial motion away from the mechanism and into position under the detector. The typical time required to change samples is from five to seven seconds.

All moving components are protected from damage due to binding by an automatic power interrupt of the drive motors. In the event of a jam, an audible signal and message alerts the operator. Teflon guides in the detector slide assembly assure accurate and repeatable sample positioning for optimum geometric efficiency. The sample changer is either manually controlled by pushbuttons or automatically controlled by the system processor.

DETECTOR ASSEMBLY

The LB 5100-PW utilizes a 2 inch diameter phoswich scintillation detector. The phoswich detector is composed of a calcium fluoride [CaF_2 (Eu)] primary detecting crystal coupled to a sodium iodide [NaI(Tl)] guard detector crystal. The entire detector assemby is mounted for easy access and cleaning, enclosed within oxygen-free high conductivity (OFHC) copper and surrounded by four inches of low background virgin lead. The lead is a very effective shield for gamma and low energy "soft" cosmic rays. The OFHC copper efficiently absorbs lead x-rays produced inside the shield and thus provides an ultra low background condition for sample analysis.



SYSTEM LINEAR ELECTRONCIS

The linear signal processing electronics for the LB 5100-PW System are modular and powered by a standard TENNELEC NIM Bin. This modular approach carries with it many years of reliability and proven performance and allows the user to conveniently isolate a problem should the system ever fail to perform properly. Replacement modules can be sent by mail to quickly return the system to operation.

NIM BIN AND POWER SUPPLY provides the proper voltages necessary for the operation of the modular electronics. Built into this instrument are:

* Power "on" and temperature "warning" indicator lights
* Line voltage filter
* Voltage monitoring test points
* Power "interrupt" indicator light
* Spare slots for future expansion or options

PHOSWICH PROCESSOR This unit is a time discriminating SCA capable of performing all of the functions necessary to classify the outputs from the phoswich detector. It includes the preamp, main shaping amp, timing and discriminating circuitry necessary to categorize the input and produces ALPHA, BETA, GAMMA, and COSMIC outputs.

DETECTOR BIAS SUPPLY A 3000 volt regulated high voltage power supply is used to bias the photomultiplier tube in the phoswich detector assembly. The bias supply features a digital indicator for accurate monitoring of the bias voltage.

OPTIONAL EQUIPMENT AND ACCESSORIES

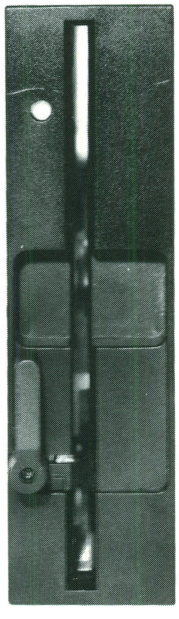
MOBILE CABINET (LBA-01) Rugged compact cabinet on wheels with collapsible shelves for the video terminal and printer. (Pictured on front cover).

100 SAMPLE CAPACITY (LBA-03) Includes 100 sample capacity stacks, 50 additional carriers coded 51 thru 100, 50 additional 2-1/16" x 1/8" inserts and 50 additional 2-1/16" x 5/16" inserts.

MCA SYNCHRONIZATION (LBA-08) This option provides three signals which can synchronize a MCA to the operation of LB 5100.

MCA READY	Input signal from the MCA which indicates that the MCA is in the acquire mode if signal is a TTL high level.
LB 5100 READY	Output signal from the Processor/Controller with a TTL high level indicating the LB 5100 has sample in position and is ready to count.
PRESET TIME	A low going TTL compatible pulse (nominally 5 μsec wide) indicating that the LB 5100 counting timer has timed out.

FLOPPY DISK STORAGE Either a single drive (LB 5120-01) or a dual drive (LB 5120-02) floppy disk option can be mounted in the System Processor/Controller. The disks are 5-1/4" diameter dual sided, double density with a storage capacity of 368 kbytes per disk. Operating parameters, sample data, constants tables and special programs can be stored on the disks using the LB 5100 DOS. A single diskette can hold the raw data from over 5700 samples.

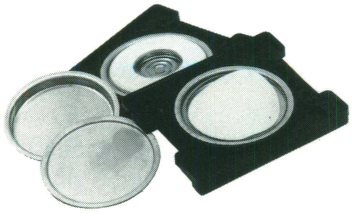


PC-DOS CONVERSION PROGRAM Due to the popularity of the IBM Personal Computer, TENNELEC has made available a conversion program (LBA-11) which allows LB 5100 data files to be converted and transferred onto a PC-DOS formatted diskette. also included is a BASIC Program which will access and print the converted data file under the PC-DOS environment. This program can be easily modified to provide data reduction on the personal computer.

CARRIERS Additional BCD coded sample carriers are available in lots of 50 each coded:

1 - 50 P/N 6200-0096
51 - 100 P/N 6200-0097
101 - 150 P/N 6200-0088

CARRIER INSERTS Additional stainless steel inserts are available in depths of 1/16", 1/8" 1/4" or 5/16". These inserts are available for either 1" or 2" planchets. Refer to the TENNELEC SYSTEMS PRICE LIST for part numbers and prices.



CARRIER CASSETTE (P/N 1750-0023) Capable of holding 50 carriers these cassettes are very useful when samples must be transported from a preparation lab to be loaded onto the LB 5100 System.

SYSTEM PERFORMANCE

DETECTOR BACKGROUND
2" Detector: alpha $\leqslant$ 0.1 cpm
2" Detector: beta $\leqslant$ 2.0 cpm

(Measured at TENNELEC in Oak Ridge, Tennessee)

DETECTOR EFFICIENCY
beta $\geqslant$40% for ^{90}Sr - ^{90}Y
alpha $\geqslant$35% for ^{210}Po
gamma $\geqslant$30% for ^{57}Co

ALPHA-BETA CROSSTALK
Counting ^{210}Po and ^{90}Sr, with ^{90}Sr adjusted for maximum efficiency and $\leqslant$1.5% crosstalk into the alpha channel, there will be a $\leqslant$10% crosstalk for ^{210}Po into the beta channel. Less than 1% of ^{57}Co gammas will fall into the beta range.

GAMMA RESOLUTION
$<$10% FWHM in NaI(Tl) guard crystal for ^{57}Co (122KeV).

SAMPLE COUNT RATE
500,000 cpm with $<$1.5% dead-time loss

SAMPLE CHANGER CAPACITY
50 samples standard or 100 samples optional

SAMPLE CHANGEOVER TIME
Typically 5 seconds to remove one sample and replace with the next.

TIMEBASE ACCURACY
0.002% crystal timebase

COUNTING TIME
Counting time per sample can be set at any number between 0.01 minutes and 1,000,000.00 minutes.

COUNT CAPACITY
Alpha, beta and gamma counters have a capacity of 10^{10} counts with 9 significant digits.

PRESET
In addition to being able to preset time per sample, independent preset counts may be entered for either alphas, betas, or gammas. Weak sample count reject is also available.

ORDERING INFORMATION

SIZE AND WEIGHT

Electronics Cabinet
20.75"L x 20.75"W x 19.5"H; 83 lbs
52.7 cm x 52.7 cm x 49.5 cm; 37.7 kg

Sample Changer
35.0"L x 26.0"W x 30.0"H; 1430 lbs
88.9 cm x 66.0 cm x 76.2 cm; 648.7 kg

Video Terminal
21.7"L x 17.5"W x 13.4"H; 30 lbs
55.0 cm x 44.5 cm x 34.0 cm; 13.5 kg

Printer
12.9"L x 20.2"W x 5.2"H; 30.9 lbs
32.8 cm x 51.2 cm x 13.3 cm; 13.9 kg

Total System Shipping Weight
1838 lbs; 833.7 kg

POWER
or 117V $\pm$ 10%, 60 Hz $\pm$ 3%; $\sim$ 2.50 amps
or 230V $\pm$ 10%, 50 Hz $\pm$ 3%; $\sim$ 1.25 amps

ENVIRONMENT
Operating temperature 10-40°C (50-104°F)
Relative humidity 20% to 90% non-condensing

WARRANTY
One year except video terminal and printer (90 day)

MANUALS
One complete set of operators and maintenance manuals provided with each system ordered.

(Specifications subject to change without notice)

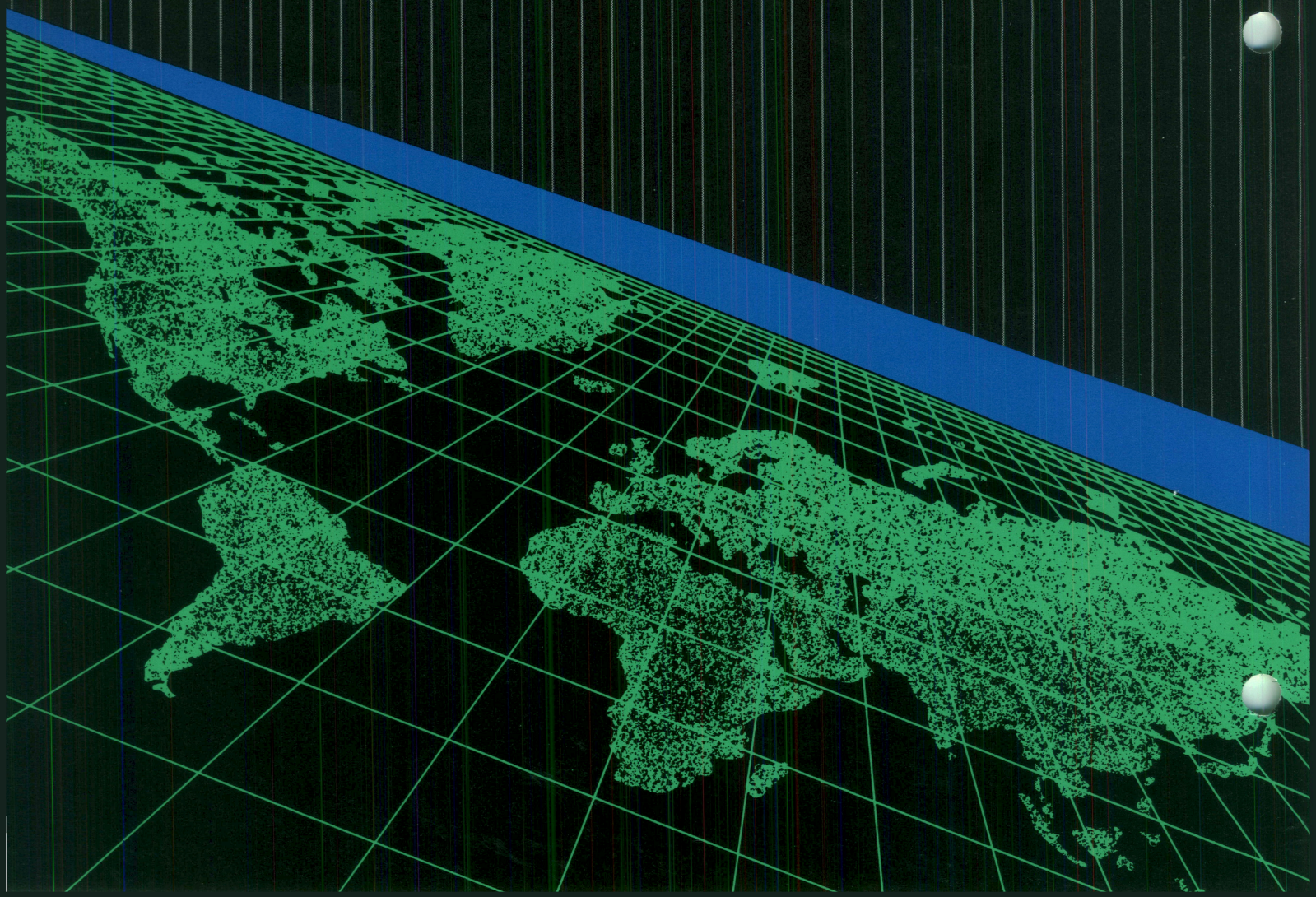
LB 5100-PW 10.0K 186

TENNELEC, Inc.
601 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830-2560
USA

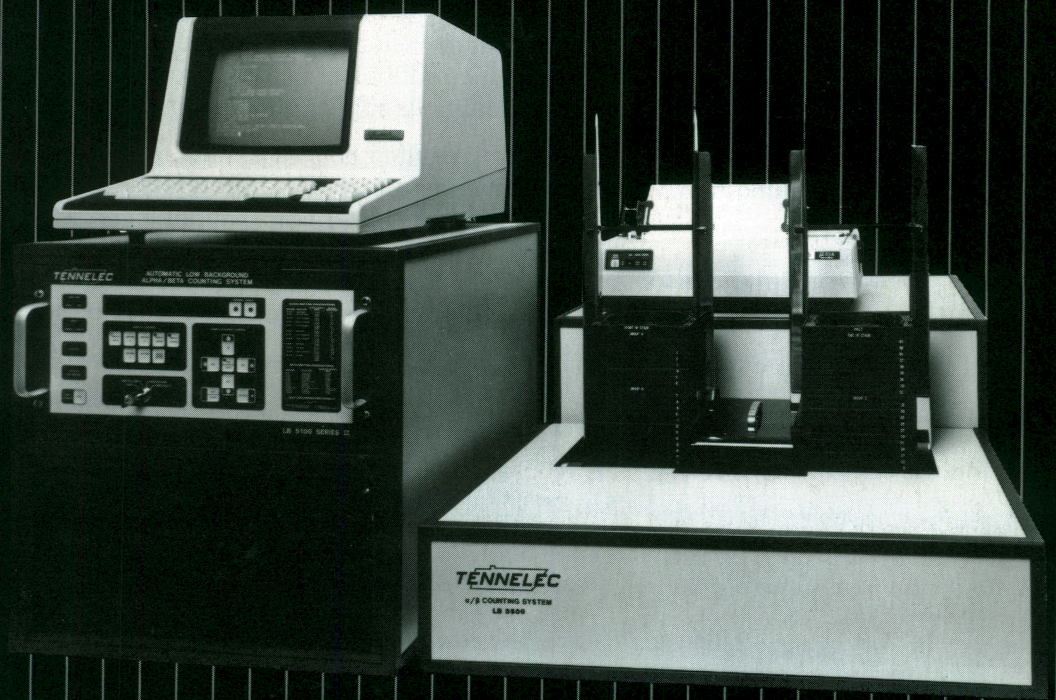
Telephone (615) 483-8405
TWX 810-572-1018

TENNELEC, GmbH
Münchner Strasse 50
D 8025 Unterhaching
WEST GERMANY

Telephone 089/611-5060
TLX 5215959 FRIE D



TENNELEC



LB 5500

5 INCH AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

INNOVATION TO MAKE IT FIRST...RELIABILITY TO MAKE IT LAST

TENNELEC LB 5500

The TENNELEC LB 5500 Automatic Low Background Alpha/Beta Counting System is an analytical instrument used to determine the gross radiation in large area low activity samples such as air filters and environmental smears.

The ultra low background and high efficiency is achievable only with time proven gas-flow proportional detector technology combined with strict system engineering and manufacturing controls. Specially selected low background materials, electronics designed for long term stability, a sample changer designed for reliable service and human engineered operation are all essential elements in a well engineered system. The resultant performance insures the determination of permissable concentrations for the most stringent of todays trace element regulations.

TENNELEC low background counting systems have become recognized as an industry standard; a standard for performance and reliability. The LB 5500 adds another dimension to this standard — flexibility. The flexibility to adapt the machine to your specific laboratory routine. The unprecedented computational capability coupled with a user defined reporting format is just one of the flexibility features. In addition automatic plateau generation, CHI square calculations and diagnostic routines provide the tools needed for a rigid Quality Assurance Program.

Ease of operation is an essential feature for any analytical instrument. The LB 5500 has not lost sight of this important fact. Routine operation is as simple as loading the samples and pressing the advance button. The technician need never concern himself with the complexities behind the resulting report.

FIGURE OF MERIT

In comparing the suitability of low background counting systems for a particular application, a relative number called a figure of merit has been used. In essence, the figure of merit expresses the number of samples (not in absolute terms) that can be counted per day to a given statistical accuracy. Regardless of the accuracy chosen, a system with a figure of merit twice that of another system can count twice as many samples in the same amount of time.

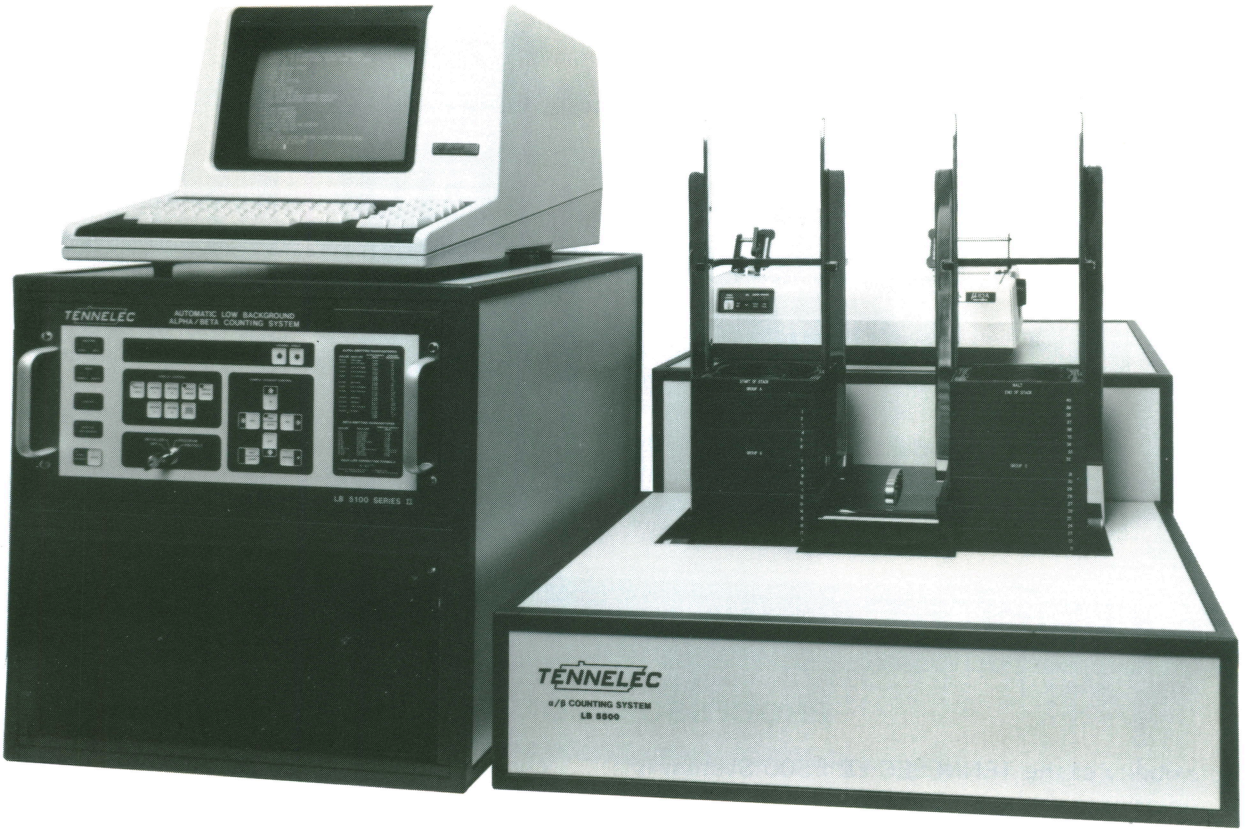
The generally accepted figure of merit for a low background counting system is expressed as the square of the absolute counting efficiency divided by the background count rate. Absolute efficiency is dependent upon counting geometry, absorption factors, intrinsic detector efficiency and detector area relative to the sample area. Background count rates arise from environmental gamma radiation, radiation from material within the system, cosmic radiation and electrical noise.

TENNELEC low background systems exhibit ultra low backgrounds by surrounding the detector with four inches of virgin lead internally lined with OFHC copper. The gas flow proportional counter is constructed from specially selected low background material. A large area cosmic guard detector rejects cosmic shower radiation. Special grounding and interference filters protect the system from electrical noise.

Counting efficiencies are optimized by maintaining less than 4 mm spacing between the sample and detector thus reducing solid angle effects and air absorption. Gas flow detectors with greater than 99% intrinsic efficiency are utilized. Gas flow rather than sealed detectors are recommended because a continuously refreshed gas supply insures that the intrinsic efficiency will not degrade with time due to gas depletion or disassociation. Also only gas flow detectors can be supplied with ultra thin entrance windows which minimize window absorptions. The detector areas are at least 12% greater than the sample area for optimum 2 π counting geometry.

The figure of merit is a measure of a systems gross counting capability. Other factors must also be considered in comparing systems. One such factor is the alpha to beta crosstalk. Systems in current use whether they use gas proportional detectors or scintillation type detectors separate alpha and beta events in simultaneous count modes by energy or pulse height discrimination techniques. Based upon published data, gas flow detectors exhibit superior crosstalk performance. Obviously these measurements are made under controlled conditions. Self absorption effects in the sample increase the difficulties in separating alpha and beta events during simultaneous counting. Here the gas proportional counter has the advantage of being able to reduce crosstalk by counting the sample for alphas only at a reduced bias. The beta contribution may then be calculated from the gross counts obtained in the simultaneous mode.

Other tangible factors in selecting a system are reliability, serviceability, data manipulation capability and convenience features. TENNELEC is proud of its efforts to provide the best in low background counting systems and support. Whatever your requirements or application, it is TENNELEC's goal to be the one company you can depend upon.

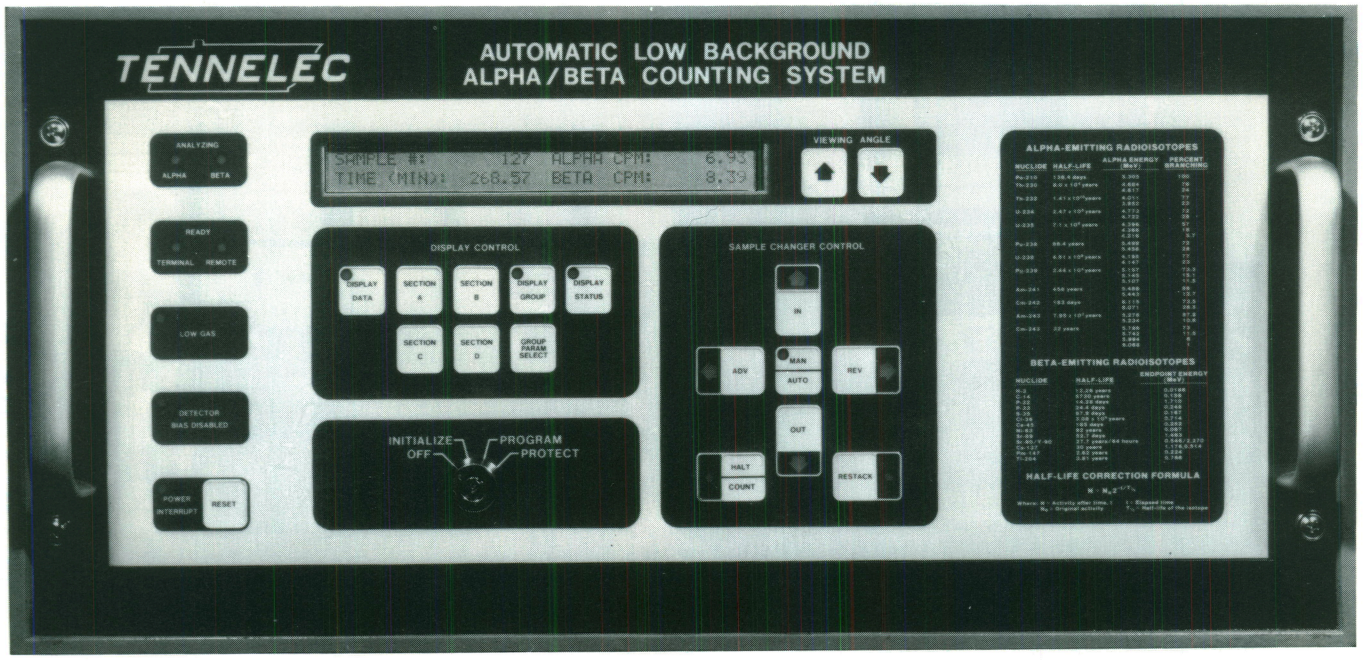


Standard Features of the LB 5500 System:

- 5.0″ diameter gas-flow sample detector.
- Ultrathin 80 $\mu gm/cm^2$ detector window.
- 100 square inch gas-flow guard detector.
- Accommodates up to 5″ diameter samples.
- Accommodates 50 sample carriers up to 5/16″ deep.
- Rapid sample changing.
- Simultaneous or separate low level alpha/beta detection.
- Ultra low background.
- Operates on P-10 gas.
- Two stage gas tank regulator included.
- Flow meter with filter and HV shut off.
- 10 independent sample groups.
- Automatic plateau generation.
- Operator defined report formats.
- Powerful operator accessible mathematics interpreter.
- Operator defined plotting routines.
- Automatic CHI square calculations.
- System diagnostics.
- Easy access detector slide assembly.
- Automatic restart after power interruption.
- 12″ diagonal video terminal.
- 120 cps printer with adjustable tractor feed.
- Time of Day/Time of Year Clock with battery back-up.
- Non-volatile memory.
- Dual independent RS-232-C input/output ports.
- Table top cabinets.
- Key-lock protected operation.

Optional Features for the LB 5500 System:

- 3.25″ diameter gas-flow sample detector.
- 500 $\mu gm/cm^2$ detector windows.
- Single or dual drive floppy disk storage.



PROCESSOR/CONTROLLER

The flexibility of the TENNELEC LB 5500 System is due primarily to the sophistication of the LB 5120 Processor/Controller. This sophistication is made possible by microprocessor technology coupled with user friendly firmware. The LB 5120 sends and receives signals which identify the samples and advance them into counting position underneath the detector. The LB 5120 then collects the sample count information from the linear electronics and corrects and reports the data in a predefined manner. User defined formats and operating parameters are stored in memory protected by battery back-up. The front panel features a liquid crystal display, sealed membrane switches, color coded status LEDs, and a tamperproof key-locking switch.

The liquid crystal display allows the operator to examine data and various operating parameters independent of the video display or the printer. Unique viewing angle controls optimize the contrast of the display.

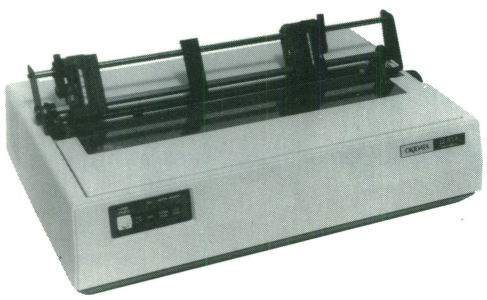
The sealed membrane switches are clustered into display control and sample changer control functions. The display control section selects either data as it is being acquired, sample group parameters (presets, etc.), or changer status (number of changer cycles left, etc.). The sample changer control cluster provides the operator with total manual control of the sample changer.

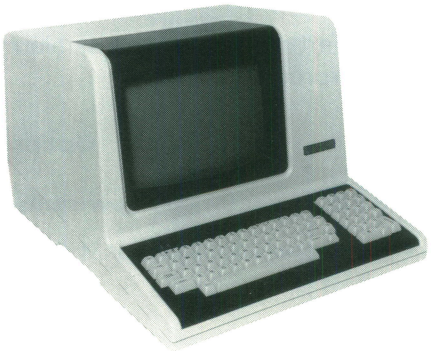
The LB 5120 front panel contains twelve green status LEDs for an at-a-glance indication of the normal functions of the system. Five red status LEDs are used to indicate conditions which may require operator attention.

Optional single or dual floppy disk drives may replace the radioisotopes table on the front panel. The floppy disk may be used to store sample data as well as user defined operational parameters.

Internally the LB 5120 features non-volatile memory, time-of-day/time-of-year clock with battery back-up, two independent RS-232-C input/output ports and a high voltage control interface. All printed circuit boards are equipped with LEDs which aid in the isolation and diagnostics of problems.

The operator communicates with the system via a video terminal with a standard ASCII keyboard and a large 12 inch diagonal screen. Hard copy is provided via a 120 character per second buffered printer. The printer has selectable character pitch and an adjustable tractor feed mechanism which accommodates paper up to 14" wide.



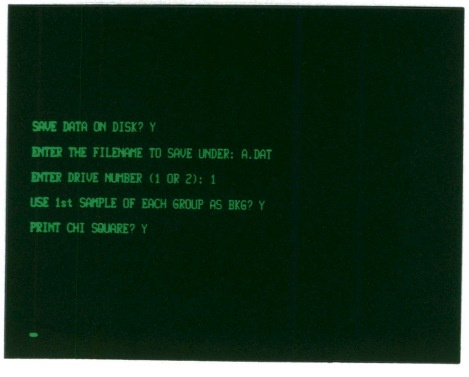


SYSTEM OPERATION

The operation of the LB 5500 is determined by the firmware of the LB 5120 Processor/Controller in conjunction with operator entered parameters. At the executive level a menu of commands can be generated on the screen. These one letter commands will begin a counting sequence, call set-up routines, execute various changer operations or enter one of the utility routines.

Once the LB 5500 set-up has been accomplished, the operation is as simple as loading the samples and telling the system to **Begin** counting. If operation is initiated in this fashion, the operator will be allowed to store data on the optional disks, select the source of the background data, and perform CHI square calculations.

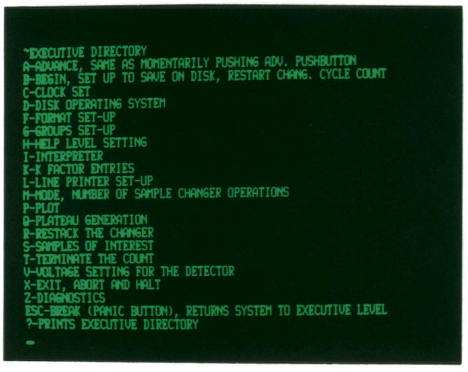
The optional disk will allow raw data such as gross counts, counting time, etc., to be stored on the disk under the file name specified by the operator. This allows the operator to archive the data for future reference. Data in a disk file can be printed



(in any format), plotted or transmitted to a centralized computer system.

Another unique feature of the LB 5500 is the choice of sources for the background count data. The system may be profiled and the resulting background data stored in memory to be used during background subtraction calculations. The operator also has the option of placing a background sample in front of a group of samples and electing to use the data collected from this first sample as the background data.

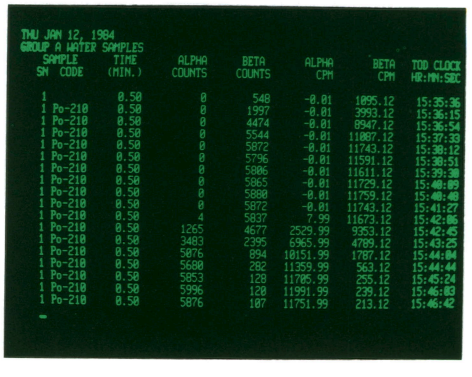
The LB 5500 can also perform CHI square calculations in conjunction with the averaging mode. The system will recount the sample N number of times (N is entered as a group parameter) and after the last counting interval the CHI square values for the Alpha, Beta and Gamma counts will be calculated and printed. This procedure can be incorporated into a Quality Assurance program by counting a prepared standard to insure that the LB 5500 reproduces the count within statistical limitations.



The LB 5500 set-up consists of establishing the report format, group counting parameters, sample changer operating modes and detector bias settings. Once the set-up has been accomplished the non-volatile memory of the LB 5500 will maintain this information indefinitely. The optional floppy disk storage media also allows any number of set-up conditions to be established and stored for easy retrieval. This permits the system to be shared in a central lab by numerous operators, each with their own unique set-up parameters.

The **Format** specifies the content and structure of the report generated from collected sample data. The format contains the column headers and defines the arithmetics to be performed on data prior to printing. The arithmetics utilizes the powerful LB 5500 interpreter and library of math functions for calculations as simple or as complex as the user requires. The equations are written using a heirarchy similar to many programming languages and variable symbols specific to the LB 5500 (e.g. A=Alpha Counts, B=Beta Counts, T=Time, etc.). In addition to variables set by collected sample data, an array of 256 user defined constants (K (n) where n=o to 255) may be incorporated. The values assigned to these constants are defined by the operator. This array can be used to construct weight tables, flow rate information for air samples, etc.

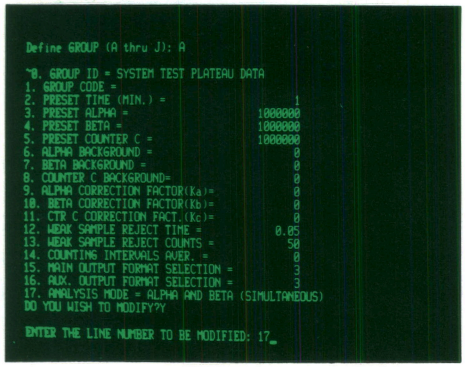
Ten unique formats can be stored in the LB 5500 memory. Four of these formats have been predefined and can be used immediately. The remaining six formats are totally user defined.



THU JAN 12, 1984
GROUP A WATER SAMPLES

SAMPLE SN	CODE	TIME (MIN.)	ALPHA COUNTS	BETA COUNTS	ALPHA CPM	BETA CPM	TOD CLOCK HR:MM:SEC
1		0.50	0	548	-0.01	1095.12	15:35:36
1	Po-210	0.50	0	1997	-0.01	3993.12	15:36:15
1	Po-210	0.50	0	4474	-0.01	8947.12	15:36:54
1	Po-210	0.50	0	5544	-0.01	11087.12	15:37:33
1	Po-210	0.50	0	5872	-0.01	11743.12	15:38:12
1	Po-210	0.50	0	5796	-0.01	11591.12	15:38:51
1	Po-210	0.50	0	5806	-0.01	11611.12	15:39:30
1	Po-210	0.50	0	5865	-0.01	11729.12	15:40:09
1	Po-210	0.50	0	5880	-0.01	11759.12	15:40:48
1	Po-210	0.50	0	5872	-0.01	11743.12	15:41:27
1	Po-210	0.50	4	5837	7.99	11673.12	15:42:06
1	Po-210	0.50	1265	4677	2529.99	9353.12	15:42:45
1	Po-210	0.50	3483	2395	6965.99	4789.12	15:43:25
1	Po-210	0.50	5076	894	10151.99	1787.12	15:44:04
1	Po-210	0.50	5680	282	11359.99	563.12	15:44:44
1	Po-210	0.50	5853	128	11705.99	255.12	15:45:24
1	Po-210	0.50	5996	120	11991.99	239.12	15:46:03
1	Po-210	0.50	5876	107	11751.99	213.12	15:46:42

The LB 5500 comes equipped with ten group plates labeled A through J. These plates are placed in front of a group of samples as they are loaded onto the changer and determine which set of counting parameters are to be used for that group. Any of the parameters can be modified by displaying the **Group** table, entering the line number of the parameter to be modified and then entering the new value. Group tables may also be stored and retrieved from the optional floppy disk.



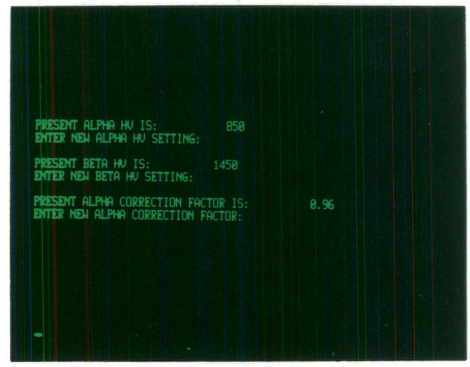
There are a total of eighteen group parameters including a 128 character ID, an 8 character code, presets, backgrounds, correction factors, weak sample reject values and the number of repeat counts before averaging. The latter parameter will allow each sample to be counted and reported the specified number of times and the average for these counts to be computed and reported.

The reporting format for the group is designated by entering the appropriate format number. One of the four standard formats or one of six user defined formats may be specified. Different formats can be selected for simultaneous output to the two output ports. The main output port refers to the terminal and printer while the auxiliary output can be any RS-232-C device (e.g. a remote computer).

One of three analysis modes can be selected for each group of samples: **simultaneous alpha and beta** where the separation of alpha and beta is determined by the pulse height discrimination technique; **alpha only** where the detector is biased at a level where it is sensitive only to alpha particles; or **alpha then beta** where the sample is first counted in the alpha only mode then recounted in the simultaneous mode to determine the contribution of betas. The alpha then beta mode also incorporates an alpha correction factor which is determined and entered by the user. This mode may produce better results (less alpha into beta crosstalk) than the simultaneous mode for thick samples where self-absorption effects are prevalent.

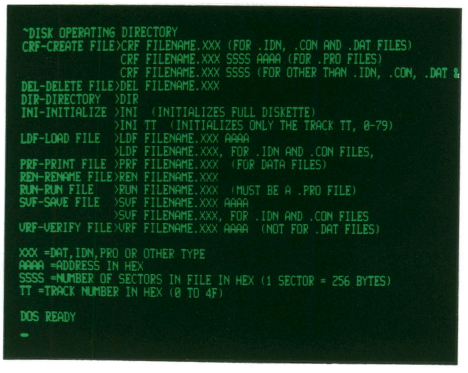
The operator may select the number of times the samples are sequenced through the changer by using the **Mode** command. If a zero is entered, the samples will be counted once and left in the receiving stack. Any other positive integer will cause the changer to sequence and restack the samples to the load position for the specified number of times.

The Detector **Voltage** Bias is controlled by the LB 5120 processor/controller. Two operating bias levels and a plateau correction factor must be entered in order for the system to properly execute the analysis modes. The operating biases are determined by generating detector plateaus using an alpha and a beta source. The alpha only bias level is set on the alpha plateau at a point below the beta sensitivity. The simultaneous (beta) level is set at a point where both the alpha and beta plateaus overlap. The plateau correction factor represents the relative counting efficiency for an alpha standard counted at the alpha only bias level versus the beta bias level. The alpha correction factor is utilized in the alpha then beta analysis mode.

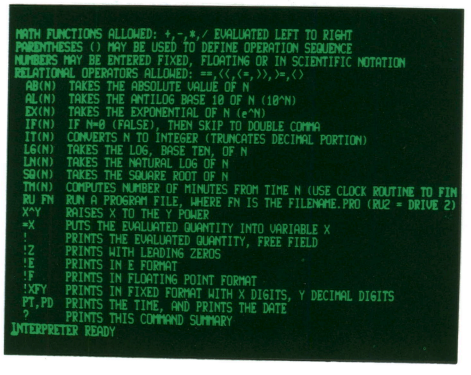


UTILITY ROUTINES

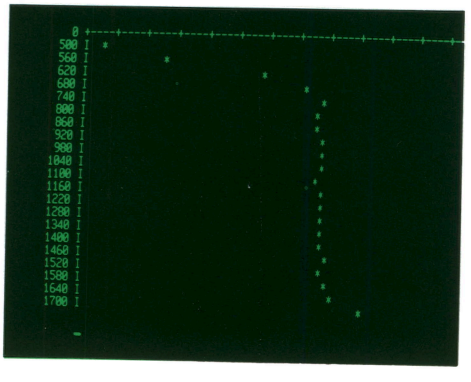
The LB 5500 firmware includes a number of utility routines which complement the general operation of the system. Routines are accessible at the executive level which allow the user to initiate various changer operations from the keyboard such as the advancing and restacking of samples. A **Clock Set** routine is available for setting the time when necessary. A **Line Printer** routine allows the user to set up form-feed operation and select print size for reports. A **Diagnostics** routine allows the operator to run one of several tests which checks for proper switch functions, exercises front-panel LEDs and verifies the system's random access and read only memories. A **Help Level** routine allows the operator to suppress certain menus.



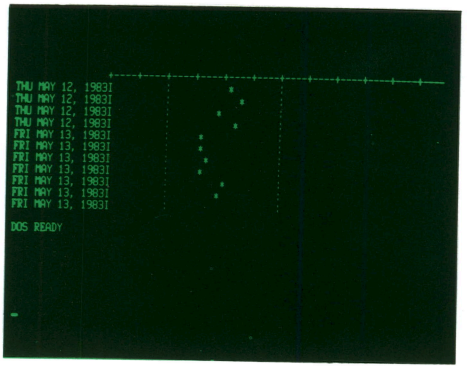
A **Disk Operating System** routine allows the operator to manipulate files on the optional floppy disks. Files can be created, deleted, printed, plotted, etc. by utilizing the various commands of the DOS.



The LB 5500 **Interpreter** can be directly accessed from the keyboard to perform real time calculations in a similar fashion to a calculator. This is the same interpreter accessed by the formatted output routines. The interpreter includes a library of the most frequently used math functions.



A **Plateau Generation** routine allows the operator to automatically produce detector plateaus. Any number of test sources may be loaded and specified along with the starting voltage, ending voltage and voltage increments and the system will collect the plateau data unassisted.



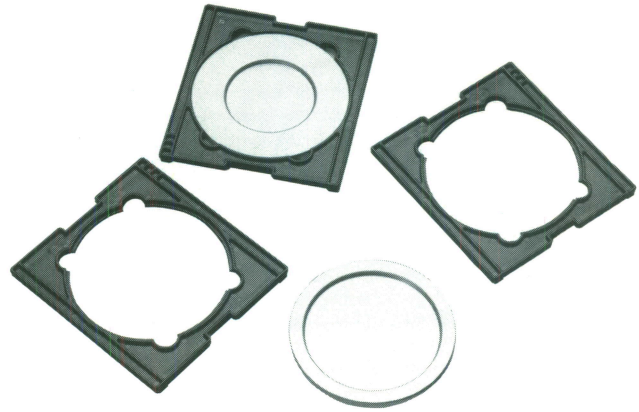
The **Plot** routine is provided to generate graphic representations of data collected from samples and stored in memory or a disk file. The equations to be used for the plot, number of variables, variable symbols and axis labels are all user defined. The operator can plot detector plateaus, historical background or efficiency performance, etc.

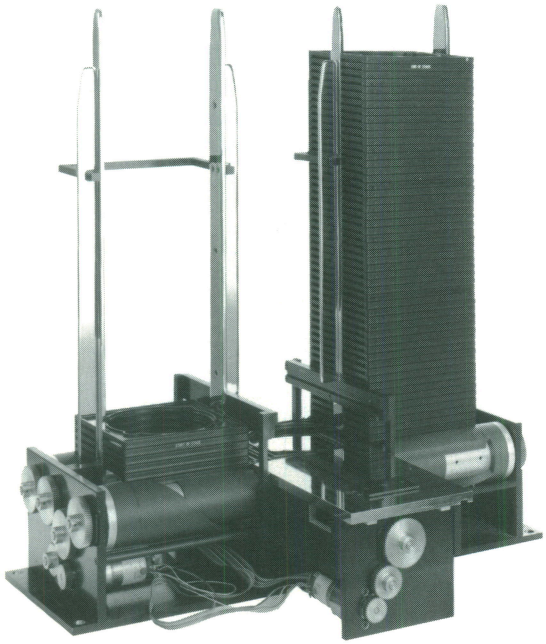
SAMPLE CARRIERS

The LB 5500 uses individually coded carriers to transport the sample to the shielded detector. Each carrier is identified by the pattern of magnets along its edge. The carriers may be coded from 1 to 150.

Stainless Steel inserts are provided for each carrier. These inserts are available to accept 3, 4 ot 5 inch diameter samples. Insert depths are available for 1/16", 1/8", 1/4" or 5/16" deep samples. Samples may be placed directly in the inserts for counting or in standard planchets.

Each LB 5500 system is supplied with fifty carriers (coded 1 to 50) and fifty inserts.





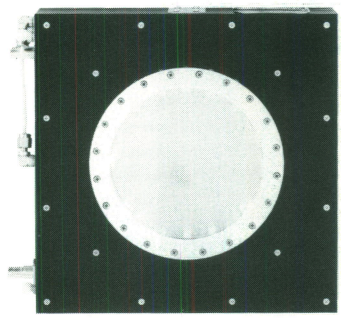
SAMPLE CHANGER

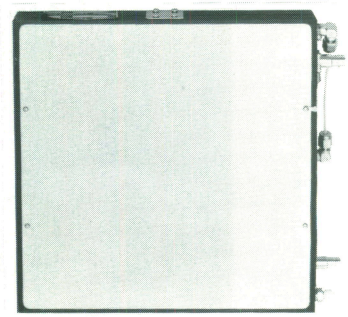
The Sample Changer assembly will accommodate 50 samples. It is microprocessor controlled and employs the fewest possible number of moving parts to insure low wear and high reliability. The basic mechanism consists of three lead screws, gear driven by dc motors. Two parallel lead screws move the sample to a center position in line with and between the input and output sample stacks. A third lead screw then moves the sample perpendicular to the initial motion away from the mechanism and into position under the detector. The typical time required to change samples is from five to seven seconds.

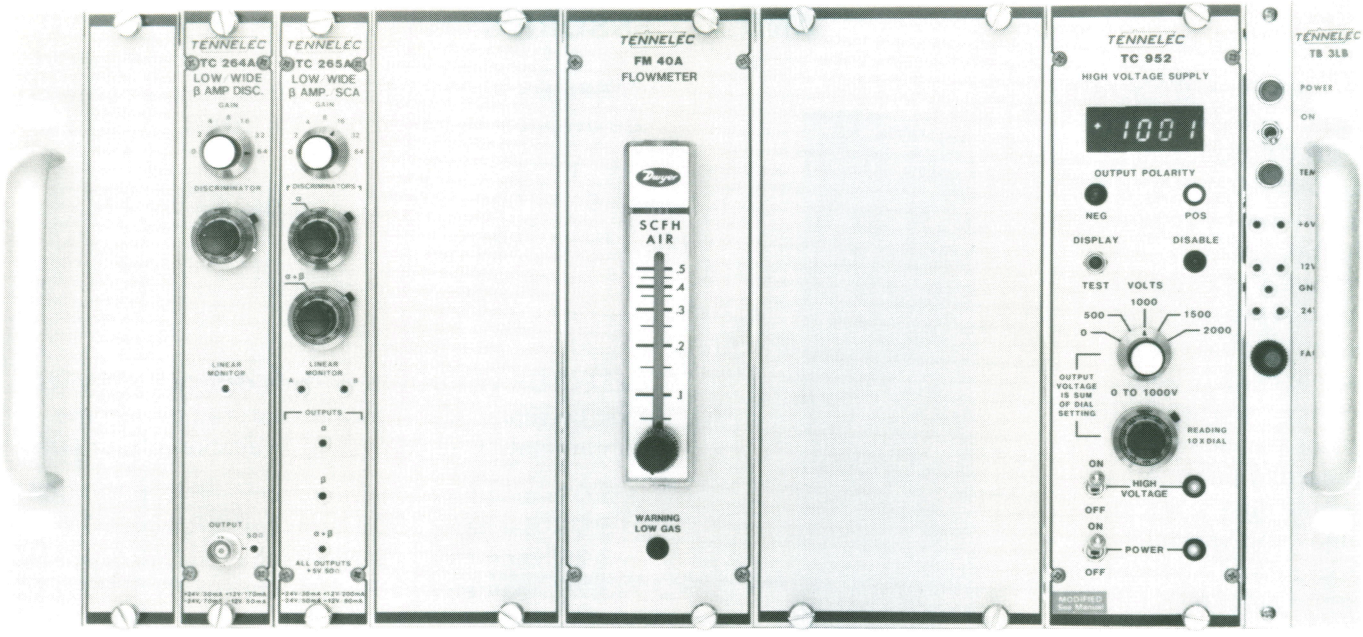
All moving components are protected from damage due to binding by an automatic power interrupt of the drive motors. In the event of a jam, an audible signal and message alerts the operator. Teflon guides in the detector slide assembly assure accurate and repeatable sample positioning for optimum geometric efficiency. The sample changer is either manually controlled by pushbuttons or automatically controlled by the system processor.

DETECTOR ASSEMBLY

The LB 5500 Detector Assembly consists of two "pancake" type gas flow proportional counters stacked on top of each other. The upper guard detector senses high energy cosmic radiation while the lower detector analyzes alpha and beta radiation emitted from the sample below. The sample detector is standardly 5" diameter with an 80 $\mu gm/cm^2$ window. 3.25" diameter detectors and 500 $\mu gm/cm^2$ windows are also available. The entire detector assembly is mounted in a slide assembly for easy access and cleaning, enclosed within oxygen-free high conductivity (OFHC) copper and surrounded by four inches of low background virgin lead. The lead is a very effective shield for gamma and low energy "soft" cosmic rays. The OFHC copper efficiently absorbs lead x-rays produced inside the shield and thus provides an ultra low background condition for sample analysis.







SYSTEM LINEAR ELECTRONCIS

The linear signal processing electronics for the LB 5500 System are modular and powered by a standard TENNELEC NIM Bin. This modular approach carries with it many years of reliability and proven performance and allows the user to conveniently isolate a problem should the system ever fail to perform properly. Replacement modules can be sent by mail to quickly return the system to operation.

NIM BIN AND POWER SUPPLY provides the proper voltages necessary for the operation of the modular electronics. Built into this instrument are:

* Power "on" and temperature "warning" indicator lights
* Line voltage filter
* Voltage monitoring test points
* Power "interrupt" indicator light
* Spare slots for future expansion or options

PREAMPLIFIERS designed for low noise proportional counters distribute high voltage to their respective detector and amplify the charge input signal for transmission to the appropriate NIM amplifier.

GUARD AMPLIFIER/DISCRIMINATOR Amplifies the pulses from the guard detector preamplifier and generates a blocking pulse for each input signal that exceeds the adjustable discriminator.

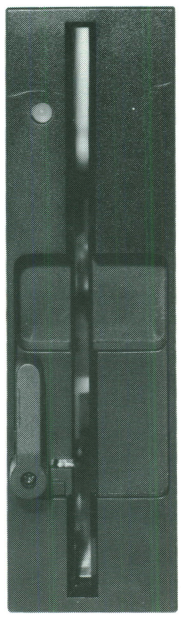
SAMPLE AMPLIFIER/DUAL DISCRIMINATOR Amplifies the pulses from the sample detector preamplifier. Two discriminators are set to separate alpha and beta events in the simultaneous analysis mode. One is set above noise but below typical beta energies while the second is set above beta and below alpha energies. A wide beta feature is incorporated which expands the beta response thus enabling the system to better discriminate between low energy betas and noise. If both levels are exceeded, an output is generated indicating the detection of an alpha while if only the lower level is exceeded, an output is generated indicating the detection of a beta. All pulses are routed to the Processor/Controller for acceptance or rejection by a guard detector blocking pulse.

FLOW METER is provided adjusting the flow of P-10 gas to both detectors. The meter is calibrated in standard cubic feet per hour (SCFH) of air over the range 0.00 to 0.40 in increments of 0.05 SCFH. The flow meter has a replacable filter for contaminent removal. A built-in gas pressure sensor and circuitry is also included to indicate low gas pressure and disable the detector bias voltage. A two stage gas tank regulator is also provided and fits all standard gas tanks.

DETECTOR BIAS SUPPLY Provides the regulated high voltage to both detectors via independent outputs routed through the preamplifiers. The bias supply is remotely controlled by the System Processor/Controller.

OPTIONAL EQUIPMENT AND ACCESSORIES

FLOPPY DISK STORAGE Either a single drive (LB 5120-01) or a dual drive (LB 5120-02) floppy disk option can be mounted in the System Processor/Controller. The disks are 5-1/4" diameter dual sided, double density with a storage capacity of 368 kbytes per disk. Operating parameters, sample data, constants tables and special programs can be stored on the disks using the LB 5500 DOS. A single diskette can hold the raw data from over 5700 samples.



PC-DOS CONVERSION PROGRAM Due to the popularity of the IBM Personal Computer, TENNELEC has made available a conversion program (LBA-11) which allows LB 5500 data files to be converted and transferred onto a PC-DOS formatted diskette. Also included is a BASIC Program which will access and print the converted data file under the PC-DOS environment. This program can be easily modified to provide data reduction on the personal computer.

CARRIERS Additional BCD coded sample carriers are available in lots of 50 each coded:

1 - 50
51 - 100
101 - 150

DETECTOR WINDOWS Sample detector windows may be replaced if they are ruptured or become contaminated. Windows are available in four sizes.

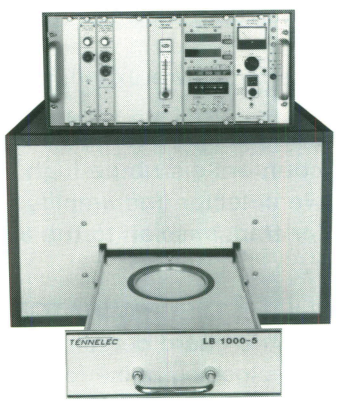
5.0" diameter - 80 μgm/cm^2	P/N 6200-0042
5.0" diameter - 500 μgm/cm^2	P/N 6200-0041
3.25" diameter - 80 μgm/cm^2	P/N 6200-0040
3.25" diameter - 500 μgm/cm^2	P/N 6200-0039

CARRIER INSERTS Additional stainless steel inserts are available in depths of 1/16", 1/8" 1/4" or 5/16". These inserts are available for either 3", 4" or 5" planchets.

3" x 1/8" (3.072" ID)	P/N 6200-0118
3" x 1/4"	P/N 6200-0119
3" x 5/16"	P/N 6200-0120
4" x 1/8" (4.412" ID)	P/N 6200-0115
4" x 1/4"	P/N 6200-0116
4" x 5/16"	P/N 6200-0117
5" x 1/8" (5.082" ID)	P/N 6200-0121
5" x 1/4"	P/N 6200-0122
5" x 5/16"	P/N 6200-0123

5 INCH MANUAL LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM

TENNELEC also offers the three- and five-inch gas-flow proportional counter with a manual sample changer assembly. The background and efficiency specifications are the same as with the LB 5500. Alpha and beta count information is presented on the dual seven digit LED displays of the NIM counter. Optional printer devices are also available for hard copy records.



SYSTEM PERFORMANCE
USING P-10 (90% Argon, 10% Methane) GAS

DETECTOR BACKGROUND
5.0" Detector: ≤5.0 cpm alpha plus beta (standard)
3.25" Detector: ≤2.0 cpm alpha plus beta (optional)

(Measured with TENNELEC specified gas in Oak Ridge, Tennessee)

DETECTOR EFFICIENCY
With 80 μgm/cm^2 window (standard)
≥30% of ^{14}C
≥40% for ^{90}Sr - ^{90}Y
≥40% for ^{210}Po

With 500 μgm/cm^2 window (optional)
≥20% for ^{14}C
≥40% for ^{90}Sr - ^{90}Y
≥35% for ^{210}Po

ALPHA-BETA CROSSTALK (Simultaneous mode)
For a typical 5.0" detector with an 80 μgm/cm^2 window counting ^{210}Po and ^{90}Sr, with ^{90}Sr adjusted for maximum efficiency and 1% crosstalk into the alpha channel, there will be a ≤3% crosstalk for ^{210}Po into the beta channel.

DETECTOR PLATEAUS
^{210}Po: ≤1.5% slope/100V; ≥800V plateau
^{90}Sr: ≤2.5% slope/100V; ≥200V plateau

DETECTOR UNIFORMITY
± 5% over 90% of window

GUARD DETECTOR EFFICIENCY
≥99% cosmic detection

SAMPLE COUNT RATE
500,000 cpm with <1.5% dead-time loss

SAMPLE CHANGER CAPACITY
50 samples

SAMPLE CHANGEOVER TIME
Typically 5 seconds to remove one sample and replace with the next.

TIMEBASE ACCURACY
0.002% crystal timebase

COUNTING TIME
Counting time per sample can be set at any number between 0.01 minutes and 1,000,000.00 minutes.

COUNT CAPACITY
Alpha and beta counters have a capacity of 10^{10} counts with 9 significant digits.

PRESET
In addition to being able to preset time per sample, independent preset counts may be entered for either alphas or betas. Weak sample count reject is also available.

ORDERING INFORMATION

SIZE AND WEIGHT
Electronics Cabinet
21.75"L x 21.75"W x 22"H; 83 lbs
55.2 cm x 55.2 cm x 55.9 cm; 37.7 kg

Sample Changer
44.0"L x 30.5"W x 30.0"H; 2045 lbs
111.8 cm x 77.5 cm x 76.2 cm; 929.5 kg

Video Terminal
21.7"L x 17.5"W x 13.4"H; 30 lbs
55.0 cm x 44.5 cm x 34.0 cm; 13.5 kg

Printer
12.9"L x 20.2"W x 5.2"H; 30.9 lbs
32.8 cm x 51.2 cm x 13.3 cm; 13.9 kg

Total System Shipping Weight
2455 lbs; 1115.9 kg

POWER
117V ± 10%, 60 Hz ± 3%; ~ 2.50 amps
or 230V ± 10%, 50 Hz ± 3%; ~ 1.25 amps

ENVIRONMENT
Operating temperature 10-40°C (50-104°F)
Relative humidity 20% to 90% non-condensing

WARRANTY
One year except video terminal and printer (90 day)

MANUALS
One complete set of operators and maintenance manuals provided with each system ordered.

(Specifications subject to change without notice)

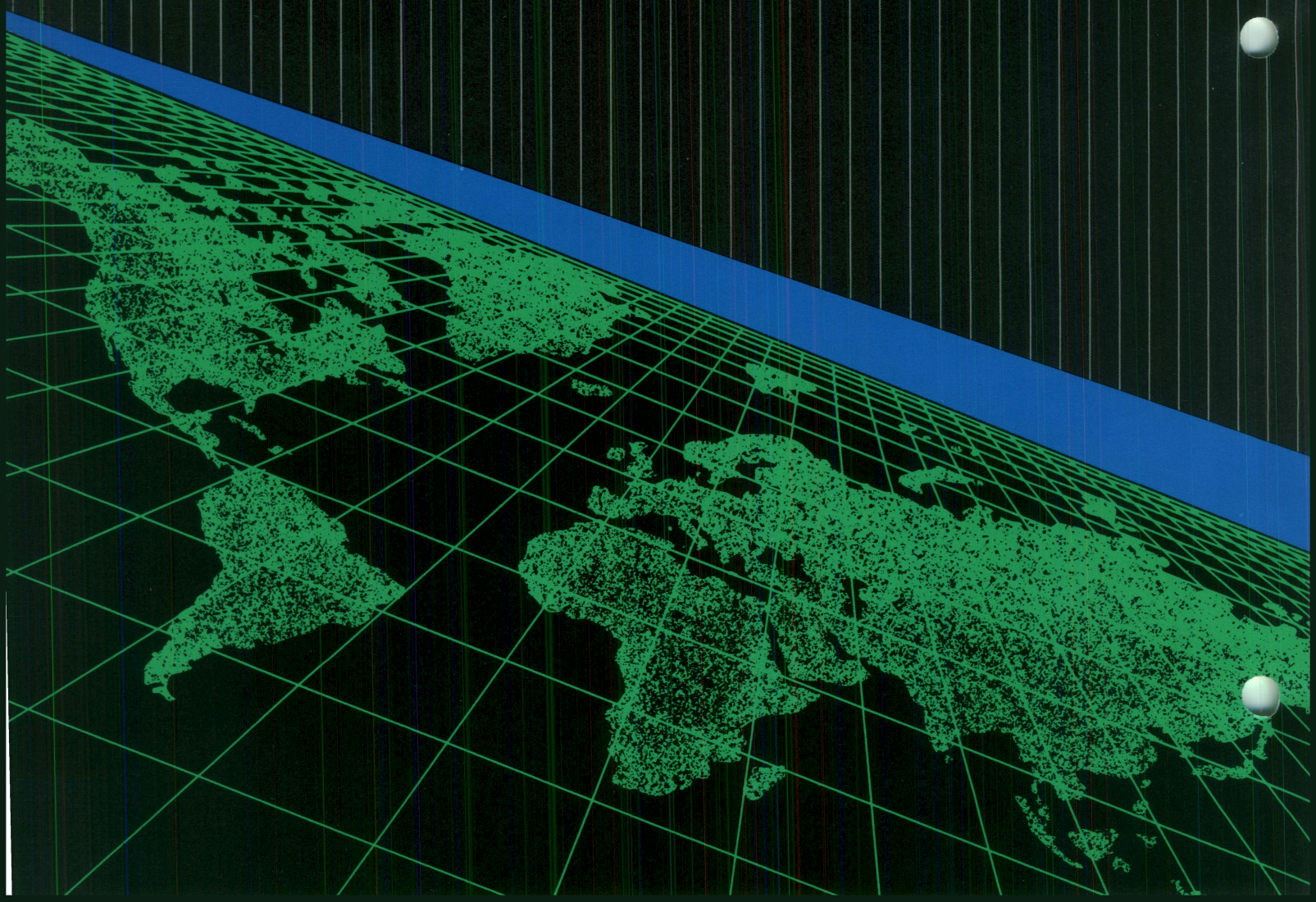
LB 5500 10.0K 186

TENNELEC, Inc.
601 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830-2560
USA

Telephone (615) 483-8405
TWX 810-572-1018

TENNELEC, GmbH
Münchner Strasse 50
D 8025 Unterhaching
WEST GERMANY

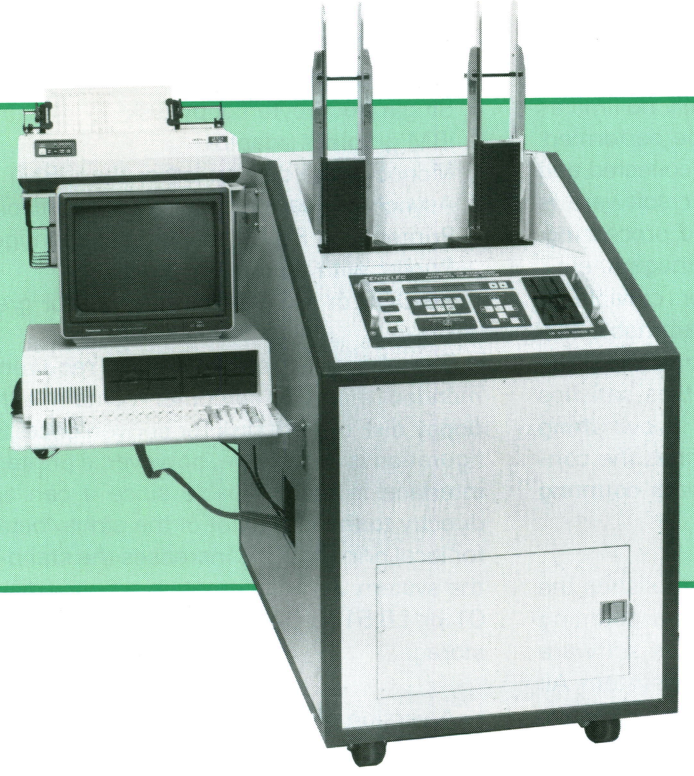
Telephone 089/611-5060
TLX 5215959 FRIE D



TENNELEC

LB 5100 Series II-PC
LB 5100-PW-PC
LB 5500-PC

AUTOMATIC LOW BACKGROUND ALPHA/BETA/GAMMA COUNTING SYSTEMS
for the PERSONAL COMPUTER



- **Computer controlled with stand alone capability**
- **Push button function selection**
- **Up to two alpha/beta systems controlled by a single computer**
- **Independent multichannel analyzer option**

DESCRIPTION

The personal computer has become a common addition to the modern analytical laboratory. The computer, though not usually required for data calculations in sophisticated instruments such as Tennelec's LB 5100 Series II, is useful in consolidating data from a variety of instruments and combined report generation. Tennelec has made it easy to integrate the personal computer into automatic low background alpha/beta counting systems.

Tennelec's alpha/beta counting systems become intelligent peripherals to the computer and are not totally dependent upon the computer. This is an important concept because it frees the computer from the routine activities of sample changer control, data collection, etc. With Tennelec's exclusive disk storage option, sample data can be collected off line and transferred to the personal computer at any convenient time. This allows **full use of the computer even while samples are being analyzed.**

The controller for the alpha/beta counting system has its own microprocessor and memory which directs the sample changer, collects and reports sample data, and monitors and displays all system status via its front panel. Its memory and separate time-of-day/day-of-year clock are equipped with battery back-up. Accurate count rate information is assured by an independent dead time corrected timer. A powerful mathematics interpreter provides for user programmable data calculations. All of this is distinct and independent of the computer. This is what is meant by an intelligent peripheral.

What role does the computer play? The operator sets up all counting conditions via the computer keyboard. This

includes preset information, sample changer modes, analysis modes (e.g., alpha only, alpha and beta simultaneously, etc.), data reporting formats, etc. All operations can now be initiated from the computer or from the front panel of the alpha/beta counting system. If the alpha/beta counting system is to be operated without supervision from the computer it must have some means of printing or storing data. This can be accomplished by either a dedicated printer or floppy disk. Refer to the configurations section of this document for a discussion of some of the common system implementations.

In general the purpose of the computer is to consolidate sample data into a written report or data base. The purpose of a system with an integrated computer is to consolidate this data without the necessity of manual reentry. Once data is in the computer environment there is virtually no limit as to the extent of data massaging which can be performed. The requirement is to insure that the data is collected and stored in a format compatible with whatever software is needed to perform the massaging (e.g., word processing, spread sheets, basic programs, data base managers, etc.). The combination of an intelligent controller capable of accumulating and transmitting data in programmable formats along with a computer interface capable of capturing this data in PC-DOS/MS-DOS[1] compatible files satisfies this need. The bonus is that each is free to do its own thing except during the actual transfers. This describes the concept of a Tennelec computer based alpha/beta counting system.

The Tennelec communications software establishes the link between the computer and the alpha/beta counting system. Executed under PC-DOS/MS-DOS, this software puts the operator in direct control of the counting system. All of the commands and features described in the respective literature for the LB 5100 Series II, LB 5100-PW or LB 5500 are now at the operators disposal through the computer.

The **communications software also provides for resource sharing** between the alpha/beta counting system and the computer. This resource sharing is implemented by **simple push button control** utilizing the function keys (F1-F7) on the computer keyboard.

```
TENNELEC LB 5100 ALPHA/BETA/GAMMA SYSTEM

EXECUTIVE DIRECTORY
A—ADVANCE, SAME AS MOMENTARILY PUSHING ADV. PUSHBUTTON
B—BEGIN, SET UP TO SAVE ON DISK, RESTART CHANG. CYCLE COUNT
C—CLOCK SET
D—DISK OPERATING SYSTEM
F—FORMAT SET-UP
G—GROUPS SET-UP
H—HELP LEVEL SETTING
I—INTERPRETER
K—K FACTOR ENTRIES
L—LINE PRINTER SET-UP
M—MODE, NUMBER OF SAMPLE CHANGER OPERATIONS
O—OPERATIONAL PARAMETERS (GROUPS) SUMMARY
P-PLOT
Q—PLATEAU GENERATION
R—RESTACK THE CHANGER
S—SAMPLES OF INTEREST
T—TERMINATE THE COUNT
V—VOLTAGE SETTING FOR THE DETECTOR
X—EXIT, ABORT AND HALT
Z—DIAGNOSTICS
ESC—BREAK (PANIC BUTTON), RETURNS SYSTEM TO EXECUTIVE LEVEL
?—PRINTS EXECUTIVE DIRECTORY
F1—Printer (OFF) F2—Capture (ON) F3—Send F4—Receive F5—Directory
F6—Quit F7—SetUp
```

SCREEN DISPLAY

These function keys enable or disable the computers printer, capture data to a PC-DOS/MS-DOS disk file, send and receive parameter files to and from the alpha/beta counting system, examine directories of a computer disk, or exit to PC-DOS/MS-DOS. A set-up function reconfigures the communications ports to other than standard hardware, e.g. change serial port baud rates or select parallel versus serial printer usage.

The minimum requirements for the computer to be integrated into a Tennelec low background alpha/beta counting system are as follows:

IBM-PC[2] or equivalent
128 kbyte memory
Single 360 kbyte floppy disk
IBM graphics adaptor
Monochrome display (other than IBM)
Asynchronous communications port configured as COM1
Printer with RS-232-C interface configured as COM2, or
Printer with parallel interface
PC-DOS or MS-DOS version 2.0 or greater

The above list is a minimum requirement. It is recommended that the computer contain either an additional floppy disk or hard disk for convenience. Either printer configuration is acceptable, however, a printer with a RS-232-C interface is more flexible since it can also be connected directly to the controller of the alpha/beta counting system for local printing. This increases the stand-alone flexibility of the system. As an alternative, a floppy disk option (LB 5120-01 or LB 5120-02) can be added to the controller for data storage.

A version of the communications software is available for controlling **two alpha/beta counting systems from a single computer**. In this configuration a parallel printer is required for the computer and two asynchronous communications ports (one for each system configured as COM1 and COM2 respectively) are required. The entire screen of the monitor can be dedicated to one system or a split screen will allow both systems to be observed simultaneously.

CONFIGURATIONS

The tremendous flexibility of the Tennelec system allows for many different hardware configurations. To assist in the selection of the optimum configuration for your specific requirement, the following is a list of possible system implementations. For clarity, block diagrams are shown followed by a brief description of benefits, advantages and disadvantages. While the personal computer can be any of a variety,

[1]PC-DOS/MS-DOS are trademarks of MICROSOFT, Inc., and are acronyms for the supervisory software used in most personal computers. The supervisory software allocates memory and other computer hardware to software written to be executed under its direction. It has software handlers to support a parallel printer interface and two serial communications ports. The designation for the two communications ports are COM1 and COM2 respectively.

[2]IBM is a registered trademark of International Business Machines Corporation.

the one common factor in all configurations is a RS-232-C serial asynchronous port configured as COM1 under PC-DOS/MS-DOS. This is the hardware connection between the computer and the alpha/beta counting system's controller.

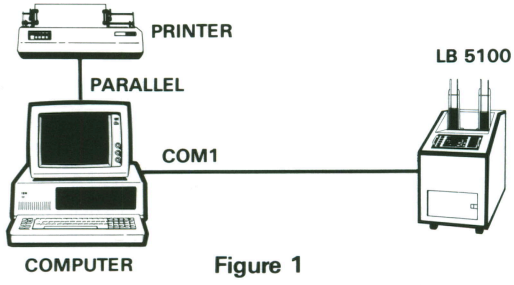


Figure 1

The configuration illustrated in figure 1 is most frequently encountered when integrating an alpha/beta counting system with an existing personal computer. The printer has a parallel output connected to the computer through a parallel interface port. It cannot be physically connected to the alpha/beta counting system. In order for the alpha/beta counting system to utilize the computer's printer, the communications link must be established during sample collection. Since the computer will be dedicated to the alpha/beta system during analysis, data can be printed and/or captured on the computer's disk. For more independent operation, the configuration of figure 4 is recommended.

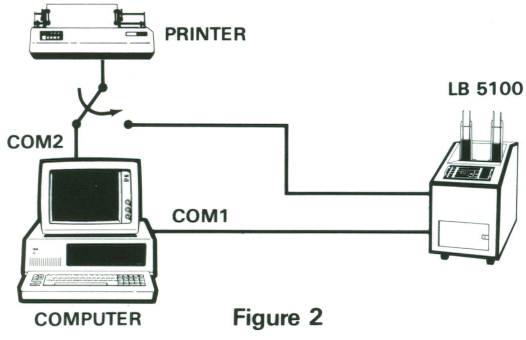


Figure 2

The configuration of figure 2 differs from figure 1 in that the printer has a RS-232-C serial interface. This printer will connect to the computer via a serial port defined as COM2 under PC-DOS/MS-DOS. The advantage is that the printer can also be physically connected to the controller of the alpha/beta counting system. This can be accomplished by either manually moving the cable or using readily available RS-232-C switches. The alpha/beta counting system now has a means of reporting data offline from the computer. **In other words the alpha/beta counting system can now collect and report sample data while the computer is used for other functions.**

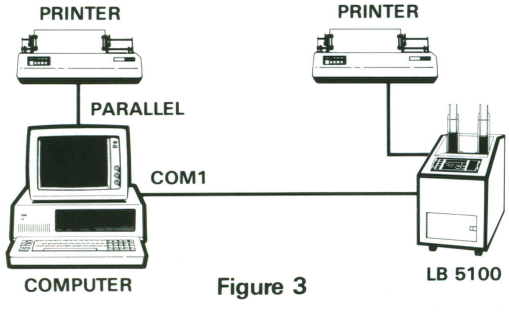


Figure 3

The configuration in figure 3 is probably the least practical of the possible configurations but not unreasonable with the propensity of unused equipment found around many laboratories. The computer and the alpha/beta counting system both have dedicated printers and can therefore operate totally independent of each other when necessary. The communications link need only be established during set-up or when sample data is to be captured on the computer disks.

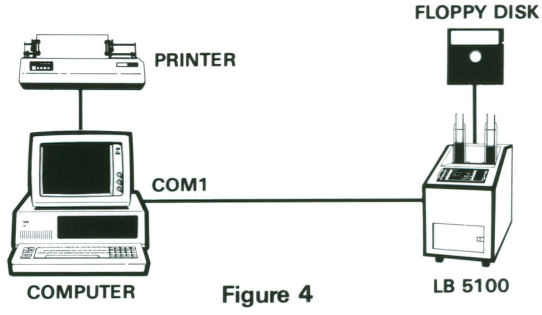


Figure 4

The preferred system configuration is illustrated in figure 4. The computer has a dedicated printer with either a parallel or serial interface. The alpha/beta counting system is equipped with either single or dual disk drives for data storage. Both systems can now operate totally independent of each other. When sample data collected and stored on the alpha/beta counting system's disks needs to be printed or transferred to the computer system's disks, the operator need only establish the communications link and select the appropriate functions. If the printer happens to be a serial output type, even greater flexibility is realized since it too can be switched from either the computer or the alpha/beta counting system.

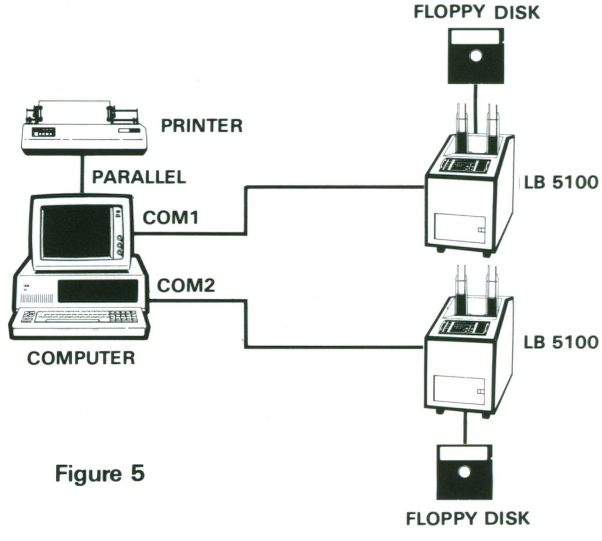


Figure 5

Two alpha/beta counting systems can be controlled by a single computer as illustrated in figure 5. This configuration requires the dual system version of the communications utility software. The printer must be a parallel output type and the computer must contain two serial interface ports configured as COM1 and COM2 respectively under PC-DOS/MS-DOS. Two independent alpha/beta counting systems can now be connected and controlled by the single computer. Although not absolutely necessary, it is highly recommended that the alpha/beta counting systems be equipped with floppy disks for this configuration.

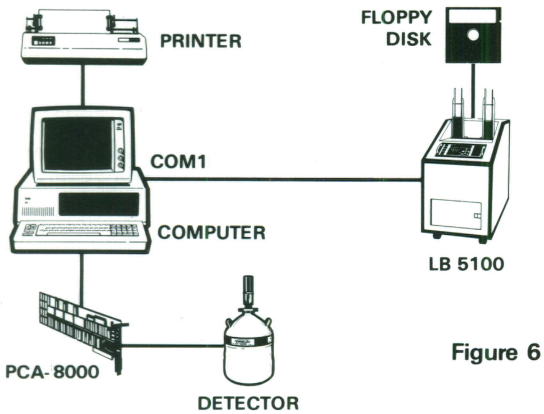


Figure 6

The concept of independent operation as applied in the modern analytical laboratory is best illustrated by the configuration in figure 6. With the addition of any one of the **three available MCA options** (PCA 1000, PCA 2000, or PCA 8000), the computer can simultaneously control the collection of alpha/beta samples, control the collection of spectral data from an independent alpha or gamma detector, and execute unrelated programs.

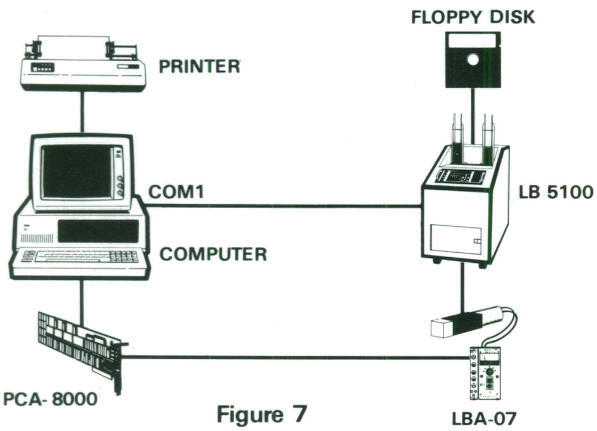


Figure 7

The configuration of figure 7 is similar to figure 6 except the personal computer MCA is connected to the NaI gamma option (LBA-07, refer to the LB 5100 Series II data sheet) of the alpha/beta counting system. This arrangement is useful when gamma spectral data needs to be collected and reported simultaneously with gross data from planchet samples loaded on the alpha/beta counting system.

ORDERING INFORMATION

-PC SPECIFICATION Any of the LB 5100 Series II, LB 5100-PW or LB 5500 versions of low background alpha/beta counting systems can be supplied in a PC version (e.g., LB 5100-2080-II-PC). When the PC version is specified, the system will be supplied with the Tennelec communications utility software on a PC-DOS/MS-DOS formatted disk, and compatible communications firmware inside the alpha/beta counting system's controller. The video terminal and printer routinely supplied with stand-alone systems will not be included.

LBA-12 This kit is available for the current owners of either an LB 5100 Series II, LB 5100-PW or LB 5500 system who wish to connect them to an IBM-PC or equivalent. Provided with this kit are two diskettes, one prom and a manual. One diskette is formatted for the personal computer and contains the PC-DOS/MS-DOS compatible communications utility software. One diskette is formatted for use with Tennelec alpha/beta counting systems with disk options. The prom is provided for use with alpha/beta counting systems not containing a disk option.

OPTIONS

PERSONAL COMPUTER Tennelec can supply any of a variety of IBM or compatible personal computers fully integrated and tested with any of the above mentioned alpha/beta counting systems. Refer to the current Tennelec system's price list for suggested packages or call the factory for a quotation on specific configurations.

LB 5120-01 Single drive floppy disk option which mounts within the alpha/beta counting system's controller. The disks are 5¼" diameter dual sided double density with a storage capacity of 368 kbytes per disk. Operating parameters, sample data, constants tables and programs can be stored on these disks. Data can be collected on these disks transparent to the computer and then transferred to the computer at the operators convenience.

LB 5120-02 Same as LB 5120-01 except contains two floppy disk drives.

PCA-1000, PCA-2000, PCA-8000 Tennelec can provide a 1024, 2048, or 8192 channel Multi-Channel Analyzer (MCA) capability for the personal computer. This option consists of a plug-in card containing an ADC and memory, plus display and acquisition software for the computer. The MCA operation can work in conjunction with or independent of the alpha/beta counting system. Generally this option is purchased in conjunction with the LBA-07 Gamma Detector option available for the alpha/beta counting systems (refer to LB 5100 Series II data sheet).

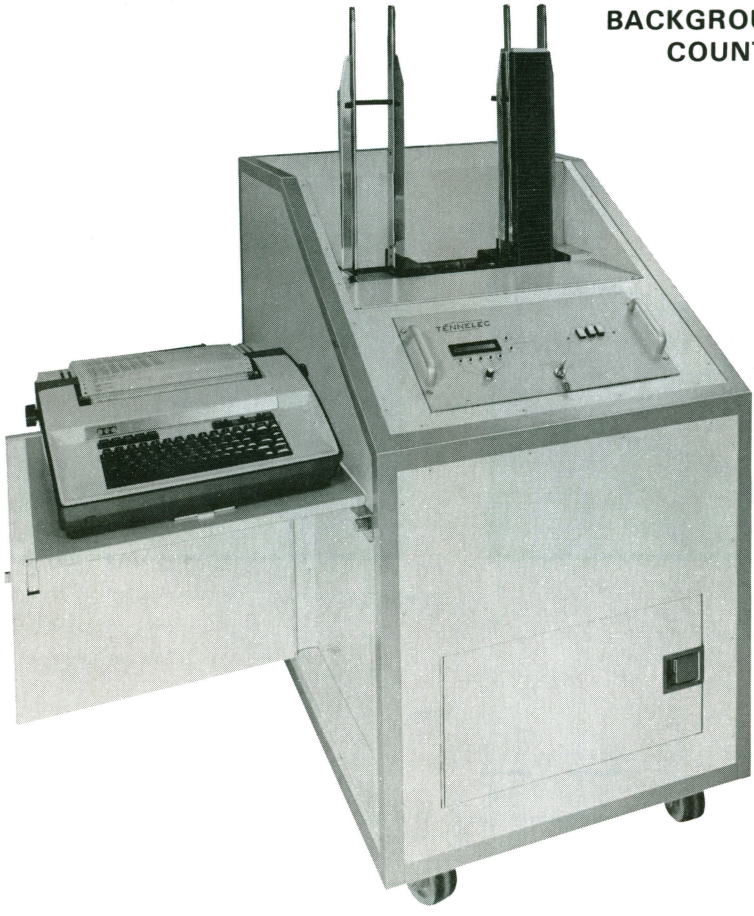
TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

LBA-01 MOBILE CABINET

for

LB 5100 SERIES AUTOMATIC LOW BACKGROUND ALPHA/BETA COUNTING SYSTEM



DESCRIPTION

The TENNELEC model LBA-01 Mobile Cabinet converts the stationary, horizontally oriented counter-top version of the LB 5100 Series Automatic Low Background Alpha/Beta Counting System to a vertically oriented movable system.

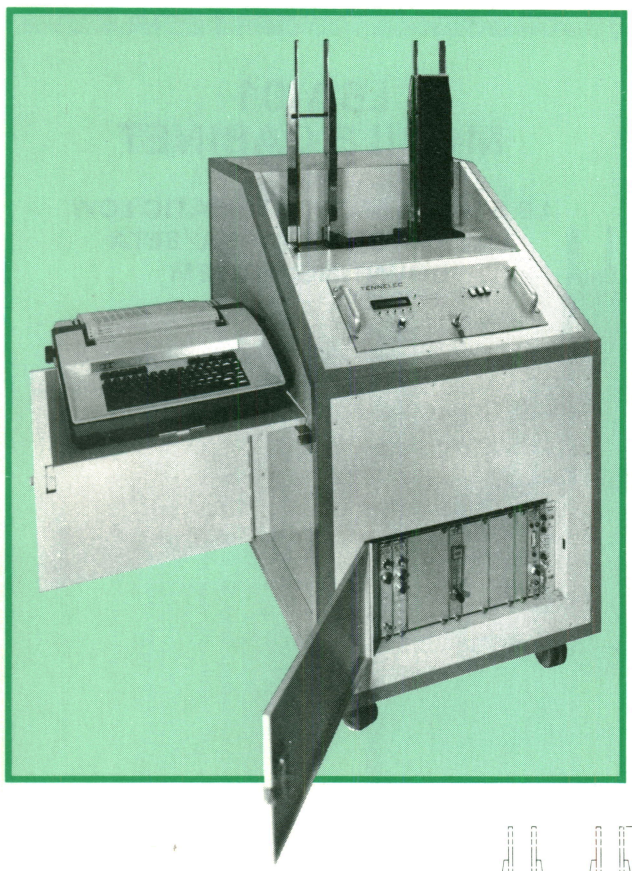
Manufactured out of heavy duty steel, the LBA-01 Mobile Cabinet allows the user the ability to move his counting system from one area to another without disassembling the system. Dimensions were chosen for structural strength and so that the system can easily fit through standard door openings. (See Figure 1)

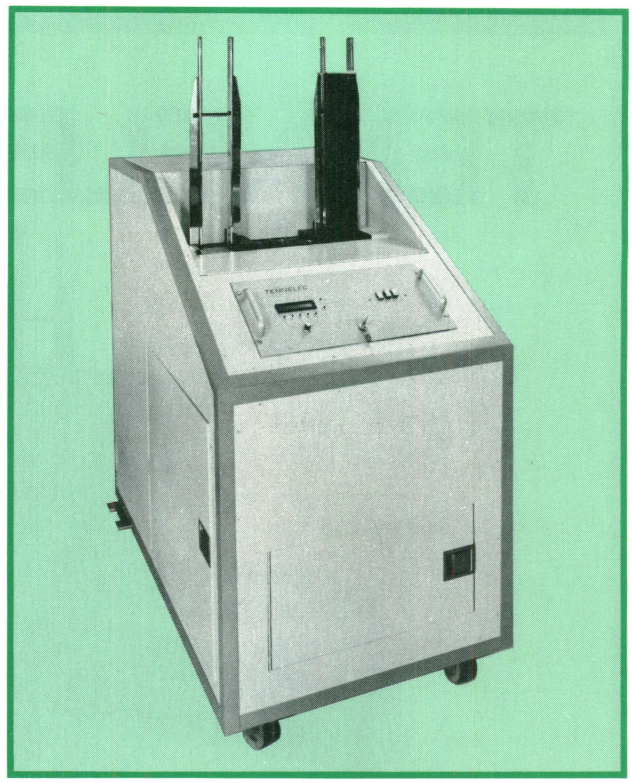
Heavy-duty five-inch wheels, two locking stationary and two swivel, allow the system to be moved and turned with very little effort.

A hinged door conceals the system NIM electronics and a flip up counter top is provided for the terminal/printer. A door is also provided on the rear of the cabinet to provide access to the lead shield assembly and to the rear of the processor/controller and NIM electronics.

INNOVATION TO MAKE IT FIRST . . .

RELIABILITY TO MAKE IT LAST





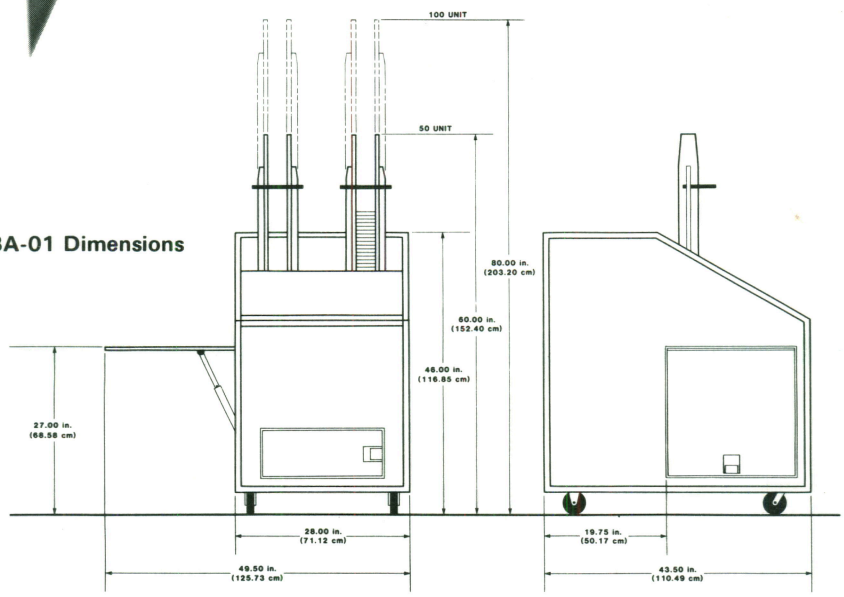


Figure 1. LBA-01 Dimensions

ORDERING INFORMATION

POWER REQUIREMENTS
None required. A power distribution strip is provided for LB 5100 Series System electronics

WEIGHT (SHIPPING) 765 lbs., 347 kg (export packed)
(NET) 385 lbs., 175 kg

DIMENSIONS See Figure 1

WARRANTY One year

NOTE: See LB 5100 Series Automatic Low Background Alpha/Beta Counting System Brochure for detailed system specifications.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

MC 10.0K 10/82

TENNELEC

APC SERIES

Automatic Planchet Counting System

INNOVATION TO MAKE IT FIRST...
RELIABILITY TO MAKE IT LAST

System Description

The **TENNELEC APC Series Automatic Planchet Counting System** is a compact, rugged, reliable system designed to provide an accurate measurement of the gross activity present in a planchet held sample.

The system will accommodate two (2) inch diameter samples up to 5/16 inch thick such as water analysis planchets or electroplated discs, leak test swipes, personnel air mask filters, stack filters, core samples, biological and zoological specimens.

The APC Series System consists of the following major components.

detector/shield assembly

A 1.75 inch diameter, end-window Geiger Mueller tube with a $\leqslant$ 2 mgm/cm^2 mica window is provided. The detector is surrounded by a 4.5" tall by 4.125" diameter lead shield with a top cable-access plug and 0.875" thick walls. This shielding essentially eliminates cross-contributions from previous and next samples to be analyzed and dramatically reduces background radiation effects.

sample changer

The sample changer will accommodate 50 or 100 (optional) samples ranging from 1/16" to 5/16" thick, 1" or 2.0" diameter. Samples of differing thickness can be intermixed without affecting sample capacity or sample to detector spacing. The changer is microprocessor controlled and employs the fewest possible number of moving parts to insure low wear, high reliability and years of continued use.

The basic mechanism consists of two parallel lead screws, metal gear driven by dc motors. The two lead screws move the sample carriers from the right-side loading stack under a sample number reader for carrier number encoding and then to a center position for analysis. Once analyzed the sample carrier is then transported to the left-side receiving stack. Sample changeover time is approximately 1 second.

Fifty (50) BCD coded sample carriers and fifty (50) 1/8" deep by 2" diameter stainless steel carrier inserts are provided. A one hundred (100) sample option is available. Additional stainless steel inserts 1/16", 1/4" and 5/16" by 2" diameter and 1/16", 1/8", 1/4" and 5/16" by 1" diameter are also available to provide a suitable holder for nearly every type of sample.

system electronics

A $\pm$ 3000 volt, 10 milliamp detector bias supply is supplied to provide operational bias to the system GM detector. A charge sensitive preamplifier converts charge created in the GM detector into pulses analyzable by the system Processor/Controller. Both instruments are contained in the system Sample-Changer cabinet.

processor/controller

The center of the TENNELEC APC Series System is the Processor/Controller. Sample changer control, data collection from the GM tube preamplifier, data correction, manipulation and transmittal to the terminal/printer, computers, mass storage devices, etc. are all performed by this instrument. The following is a list of the special features provided.

The Processor/Controller contains two (2) seven decade counters (A and B) and a seven decade crystal controlled timer.

An RS-232-C input/output is provided for user instructions from and data transmittal to a terminal/printer. An optional RS-232-C data only output is available for system interfacing to external computers, calculators, mass storage devices, etc.

The sample changer interface provides power to the changer motors and reader assemblies and receives signals to determine the sample position, motor status, sample carrier number under analysis and loading and receiving stack status.

A seven-digit front-panel LED display with selection knob and pushbuttons allows the operator to monitor sample number, counting time, channel A gross counts, channel A counts per minute, channel B

gross counts, channel B counts per minute, the date, the time of day, channel A preset background and channel B preset background. Three pushbuttons are provided to manually HALT analysis and the sample changer, ADVance the sample changer and REVerse the sample changer.

A four-position key lock is front-panel mounted. The "OFF" position turns all power off in the processor/controller, and to the sample changer motor and readers. It does not affect the terminal/printer or the detector bias supply. Turning the key through the "INITIALIZE" to the "RUN" position brings the processor to an initial start/run status requesting operator inputs for sample analysis. A fourth position, "PROTECT", locks the system on while not allowing for reprogramming of the processor, disables the terminal keyboard and protects the user entered operating parameters. This position eliminates the possibility of an accidental program change. The key is removable only in the "OFF" and "PROTECT" positions.

data reporting

A Teletype model KSR 43 Terminal/Printer is standardly supplied with each APC Series system. This terminal/printer acts as a communications link between the operator and the system and provides a hard copy printout of the sample counting results. Reported are:

THE DATE	(if option present in system) i.e. Sunday, July 4, 1982
SAMPLE NUMBER	as read from the sample carrier (independent of analysis order)
COUNTS A	gross counts collected in channel A
COUNTS B	gross counts collected in channel B
CPM A	gross counts collected in channel A divided by time less user entered background for channel A (negative results reported)
CPM B	gross counts collected in channel B divided by time less user entered background for channel B (negative results reported)
A/KA	CPM A divided by a user entered KA correction factor
B/KB	CPM B divided by a user entered KB correction factor
2 SIG A	counting uncertainty reported in percent, based on channel A gross counts
2 SIG B	counting uncertainty reported in percent, based on channel B gross counts
HR:MIN:SEC	time of day counting was terminated (if option present in system)

plotting

The APC Series system will plot A/KA and B/KB corrected data on the terminal/printer. This feature allows the user to plot detector plateaus, activity vs time for one sample, etc. without the need for an additional stand-alone plotter.

sample groups

It is often advantageous and necessary to **analyze more than one type of sample automatically**. Some samples may need to be counted longer than others to achieve the statistical accuracy required; other samples may have a higher inherent background associated with the sample taking media; and certainly the self absorption or geometric efficiency correction factors vary with sample type. The APC Series System solves this problem.

With the APC Series System, **the operator can analyze up to five different types of samples**, each having unique preset times, preset counts, channel A or channel B backgrounds and KA, KB correction factors and never have to interrupt the continuous automatic operation of the system.

Five "Group Plates", A B C D and E, are provided with each APC Series System. Each plate is coded so that when it passes through the system reader, a subroutine unique to that plate is called-up by the microprocessor controller. Every sample, after the group plate, is analyzed under that plate's subroutine conditions until either a different group plate is accessed or until the last sample is analyzed. The user can define or re-define a group plate analysis routine at any time.

In addition to being able to define unique presets, correction factors, etc. for each sample group, the user can **identify each group with up to 12 characters or letters**. This identification is printed before the header for each group analyzed.

All inputs and parameters required for sample analysis are requested of the user by way of a question and answer routine. At the end of this routine, before sample analysis begins, the system will print a listing of all five groups and the identifications, presets, etc. entered by the user. This listing clearly shows the conditions under which each sample will be counted.

sample changer modes

The APC Series System can be operated in any of four changer modes.

1. **Single Sample** Using the Processor/Controller pushbuttons or the system terminal, single samples can be accessed and counted individually.
2. **Single Cycle** System automatically counts each sample.
3. **Single Cycle and Restack** System automatically counts each sample and then restacks all samples to the original loading position.
4. **Multi-cycle** Every sample is counted, restacked and counted again until electronically or manually halted.

sample sets

In each of the three automatic modes, a set of samples can be defined by "First Sample" and "Last Sample" numbers. These samples and all in between will be automatically counted. This set of samples is definable independent of sample "Groups".

data averaging

In all four sample changer counting modes, the sample(s) can be counted from 2 to 255 times. The results of each counting interval are printed and then an additional line representing the sum and average of the previous counts is printed.

Optional Equipment and Accessories

CARRIER INSERTS Stainless steel carrier inserts are available for planchets that are 1/16", 1/8", 1/4" or 5/16" inch thick, either 1" or 2" diameter.

SPARE CARRIERS BCD coded decimal carriers are available in lots of 50 each coded 1 thru 50 or 51 thru 100.

RS-232-C DATA ONLY OUTPUT A second interface which only outputs the analysis results to external computers, calculators, mass storage devices, etc..

TIME OF DAY/TIME OF YEAR CLOCK Prints the day, month and year before each printout header and the time-of-day each sample counting is terminated.

100 SAMPLES Includes 100 sample capacity stacks, 50 more carriers coded 51 thru 100 and 50 more 2" x 1/8" stainless steel carrier inserts.

CARRIER CASSETTES Capable of holding 50 carriers, these cassettes are very useful when samples must be transported from a preparation laboratory to be loaded onto the APC Series System.

System Performance

BACKGROUND ⩽ 30 counts per minute

EFFICIENCY ⩾ 15% for Po-210 alphas
⩾ 25% for Sr-90/Y-90 betas

DETECTOR PLATEAU < 10% per 100 volts

SAMPLE CHANGER CAPACITY 50 standard, 100 optional

SAMPLE CHANGEOVER TIME approximately 1 second

SAMPLE SIZE 1 or 2 inch diameter; 1/16", 1/8", 1/4" or 5/16" thick

COUNTING TIME Up to 99,999.99 minutes in 0.01 minute increments

TIMEBASE ACCURACY 0.002%, crystal timebase

COUNT CAPACITIES 9,999,999 for channel A and channel B

Ordering Information

size and weight

SAMPLE CHANGER
13.5" L x 25.0" W x 29" H; 87 lbs
34.3 cm x 63.5 cm x 73.7 cm; 39.5 kg

MICROPROCESSOR/CONTROLLER
21.5" L x 19.5" W x 10" H; 32 lbs
54.6 cm x 49.5 cm x 25.4 cm; 14.5 kg

TERMINAL/PRINTER
21.0" L x 21.0" W x 6.0" H; 33 lbs
53.3 cm x 53.3 cm x 15.2 cm; 15 kg

TOTAL SYSTEM SHIPPING WEIGHT
225 lbs, 102 kg

POWER
117 volts ± 10%, 60 Hz ± 3%, ~ 4.5 amps
230 volts ± 10%, 50 Hz ± 3%, ~ 2.25 amps

ENVIRONMENT
Temperature +16 to +27°C; +65 to +80°F
Relative humidity 40 to 70%
Dust and radiation free

WARRANTY One year

MANUALS One complete set of operating and maintenance manuals provided with each system ordered.

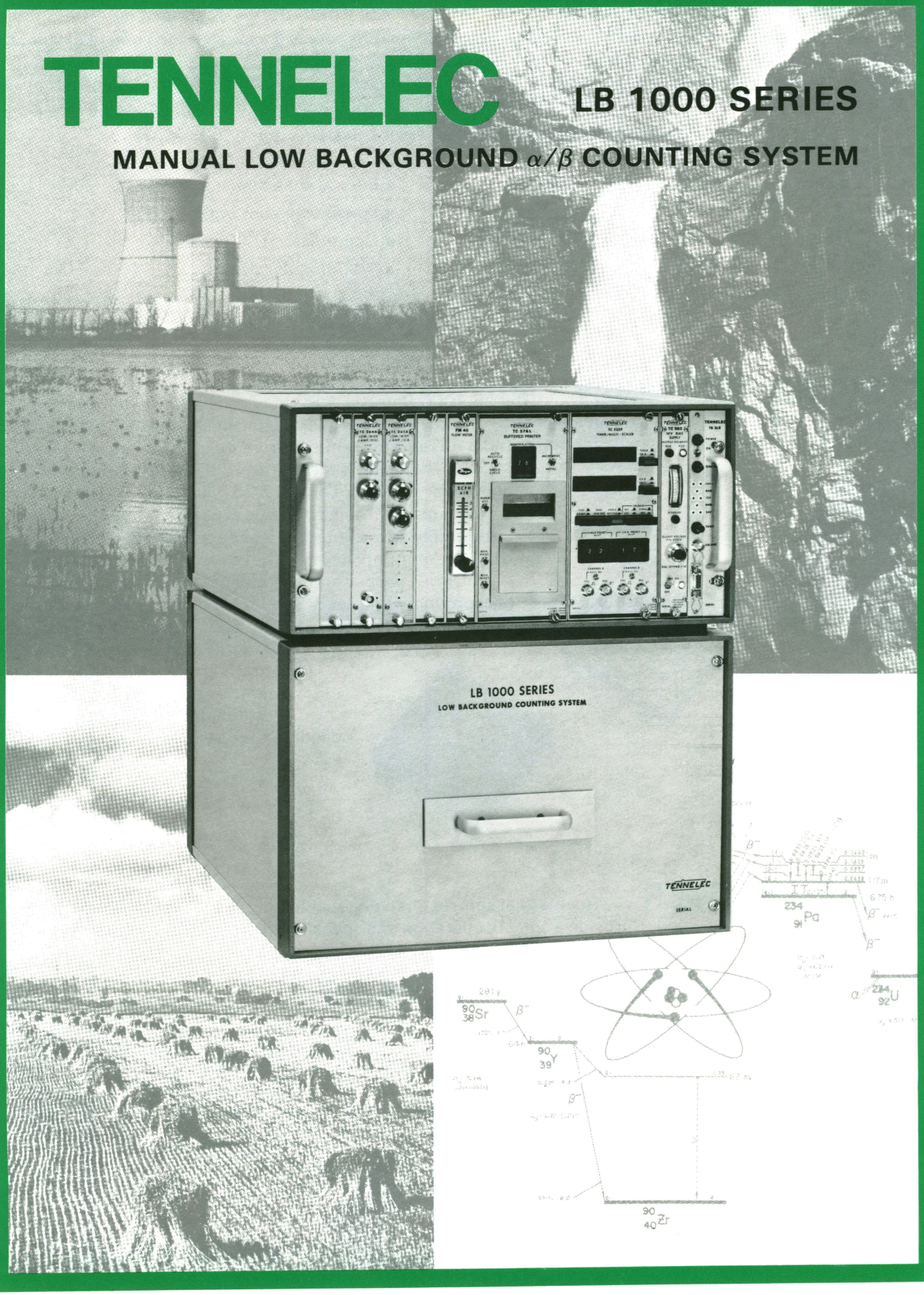
TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37830-2560, USA

TENNELEC

LB 1000 SERIES

MANUAL LOW BACKGROUND α/β COUNTING SYSTEM



INNOVATION TO MAKE IT FIRST...
RELIABILITY TO MAKE IT LAST

SYSTEM DESCRIPTION

The Tennelec LB 1000 Series Manual Low Background Alpha/Beta Counting System provides the Health Physicist and Environmentalist with the compulsory data to meet or exceed the stringent requirements of todays trace element regulations.

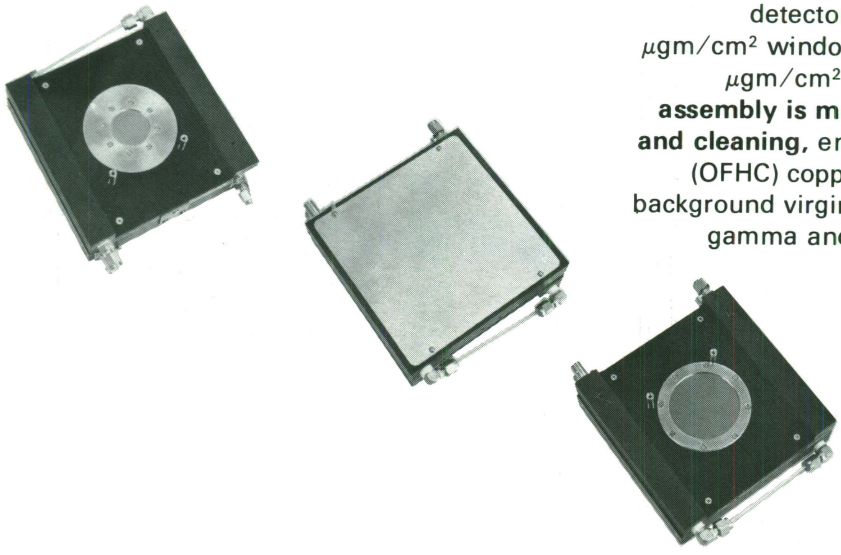
The proven reliability and interchangeability of Tennelec NIM electronics provide the foundation necessary for long term usage and the flexibility for future developments to satisfy tomorrows low level counting needs.

Some feature of the LB 1000 Series Systems are:

- Simultaneous alpha and beta counting, with minimal crosstalk
- Accommodates up to 2" diameter samples
- Ultra low background
- Precise sample positioning
- Easy access detector slide assembly
- Power interrupt indicator
- Operates on P-10 gas
- NIM modular design

DETECTOR ASSEMBLY

The LB 1000 Detector Assembly consists of two "pancake" type gas flow proportional counters stacked on top of each other. The upper guard detector senses high energy cosmic radiation while the lower detector **analyzes alpha and beta radiation** emitted from the sample below. The sample detector is standardly 1.25" in diameter with a 500 $\mu gm/cm^2$ window. Larger, 2.25" diameter, detectors and 80 $\mu gm/cm^2$ windows are available. The **entire detector assembly is mounted in a slide assembly for easy access and cleaning,** enclosed within oxygen-free high conductivity (OFHC) copper and surrounded 4π by four inches of low background virgin lead. The lead is a very effective shield for gamma and low energy "soft" cosmic rays, sometimes resulting in lead x-rays which escape toward the detector. The OFHC copper efficiently absorbs this radiation, providing **an ultra low background** condition for sample analysis.

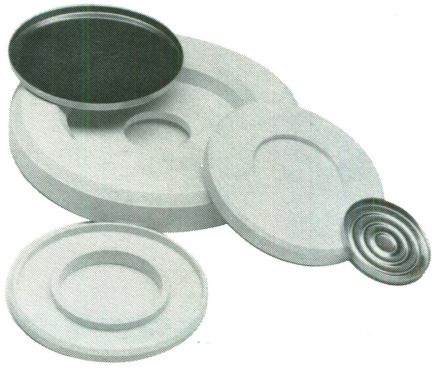


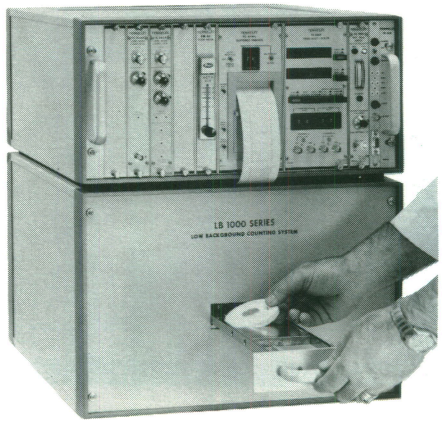
SAMPLE CHANGER

The manual sample changing mechanism is made from low background tool steel. Roller bearings are used to provide a smooth operation and opposing bearings assure repeatable sample positioning.

An interlock is included to prevent a total assembly separation, which might result in mechanical damage. The same interlock, however, allows for easy disassembly of the sample changer, should decontamination be required.

Included with all LB 1000 Series systems are six (6) sample carriers, six (6) inserts for 1" diameter planchets, six (6) inserts for 2" diameter planchets, fifty (50) 1" x 0.1" stainless steel planchets and fifty (50) 2" x 0.125" stainless steel planchets. Additional carriers, inserts and planchets are available.





THEORY OF OPERATION

When nuclear particles, such as alphas and betas, enter a gas proportional counter, the gas is ionized by the removal of one or more electrons from a number of gas molecules. This interaction forms positive ions and free electrons. (FIGURE A).

These positive ions and free electrons drift in opposite directions at a velocity that is directly dependent on electric field strength and inversely dependent on gas pressure. The collection of the free electrons at the detector electrode results in a charge pulse that is proportional to the amount of energy released within the detector by the incident nuclear particle. This charge is converted to a voltage signal which is amplified and transmitted for analysis.

Given everything else constant, the number of nuclear particle interactions that result in a pulse greater in amplitude than the systems electronic noise, is dependent on the particle (in this case, alphas or betas) and the voltage applied to the detector. FIGURE B is a graphic representation of how the number of pulses that exceed a noise discriminator is voltage dependent. The nearly flat areas of each curve, where this dependence changes the least, are the plateaus. Notice that the alpha plateau begins at a much lower voltage than the beta plateau. The primary ionization generated by an alpha is much greater than for a beta, therefore, less field strength (voltage) is required to meet the minimum pulse height requirement.

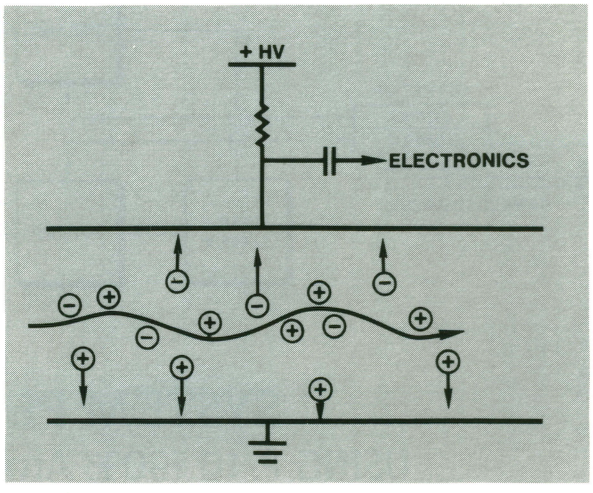


Figure A

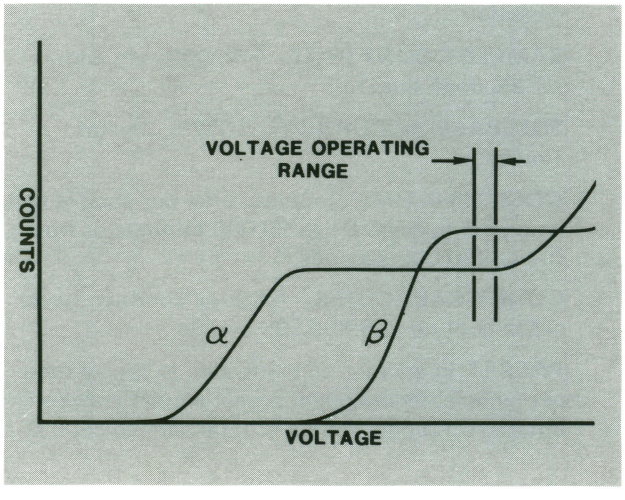


Figure B

The alpha and beta plateaus of a proportional counter overlap when using P-10 gas. The voltage operating range where the two plateaus overlap is where the detector should be operated in order to simultaneously analyze a sample for alpha and beta radiation.

When operated at a voltage where the alpha and beta plateaus overlap, a pulse height spectrum can be acquired and will look similar to the spectrum illustrated in FIGURE C. With a lower level discriminator set above noise and an upper level discriminator set between the beta continuum and the alpha peak, alphas and betas are separated and analyzed concurrently.

Tennelec Low Background Alpha/Beta Counting systems operate on these principles of analysis.

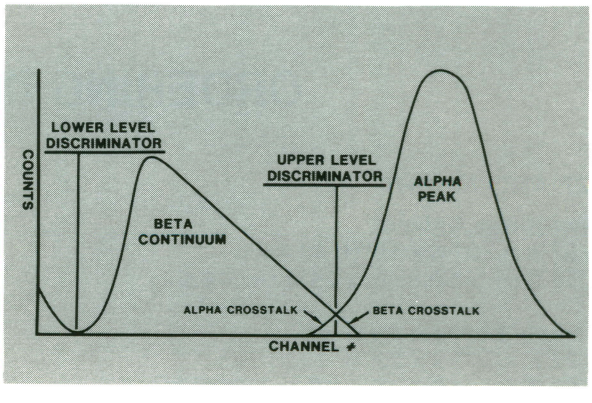
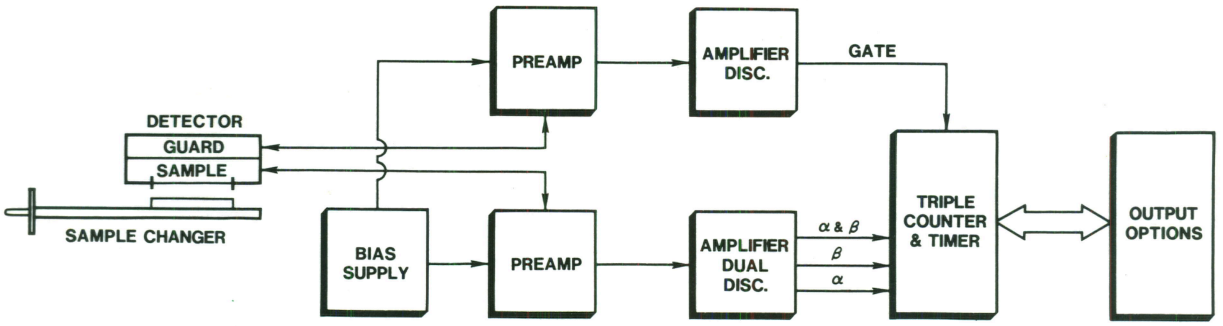


Figure C

SYSTEM BLOCK DIAGRAM



SYSTEM PERFORMANCE

USING P-10 (90% Argon, 10% Methane) GAS

DETECTOR BACKGROUND
1.25" Detector: ≤0.5 cpm alpha plus beta
2.25" Detector: ≤1.3 cpm alpha plus beta
(measured with TENNELEC specified gas in Oak Ridge, Tennessee)

DETECTOR EFFICIENCY
with 80 μgm/cm^2 window
≥30% for ^{14}C and ^{210}Po
≥40% for ^{90}Sr - ^{90}Y
with 500 μgm/cm^2 window
≥20% for ^{14}C and ^{210}Po
≥40% for ^{90}Sr - ^{90}Y

ALPHA-BETA CROSSTALK For a typical 2.25" detector counting ^{210}Po and ^{90}Sr, with ^{90}Sr adjusted for maximum efficiency and 1% crosstalk into the alpha channel, there will be a ≤3% crosstalk for ^{210}Po into the beta channel.

DETECTOR PLATEAUS
^{14}C: ≤1.5% slope/100-150V plateau
^{90}Sr: ≤2.5% slope/100V plateau

DETECTOR UNIFORMITY ± 5% over 90% of window

GUARD DETECTOR EFFICIENCY ≥99% cosmic detection

SAMPLE COUNT RATE 500,000 cpm with <1.5% dead-time loss

TIMEBASE ACCURACY 0.002%, Crystal Timebase

COUNTING TIME Counting time per sample can be preset from 00.01 to 90,000 minutes or from 0.1 to 900,000 seconds.

COUNT CAPACITIES All three counters have capacity of up to 9,999,999 counts.

PRESET In addition to being able to preset time per sample, independent preset counts may be entered for alphas, betas or total sample counts.

(Specifications subject to change without notice.)

ORDERING INFORMATION

SIZE AND WEIGHT

Electronics Cabinet
22"L x 20"W x 10"H; 43 lbs.
55.9 cm x 50.8 cm x 25.4 cm; 19.5 kg

Sample Changer Cabinet
22"L x 20"W x 23"H; 1230 lbs.
55.9 cm x 50.8 cm x 58.4 cm; 558 kg

Total System Shipping Weight: 1465 lbs. 664.5 kg

POWER
117V ± 10%, 60 Hz ± 3%; ~1.0 amps or
230V ± 10%, 50 Hz ± 3%; ~0.5 amps

ENVIRONMENT Operating temperature 16-27°C (65-80°F); relative humidity 40-70%; dust and radiation free

WARRANTY One year

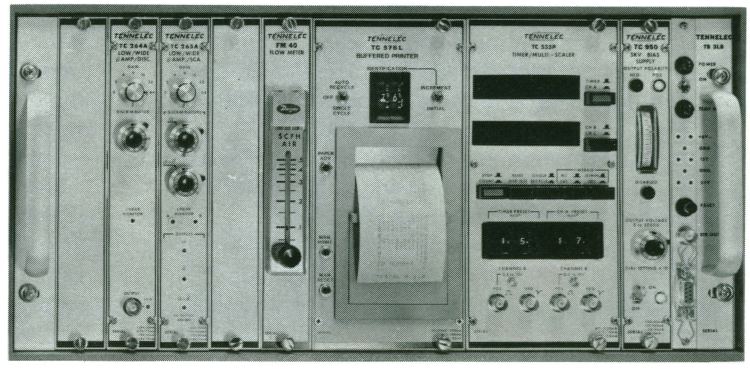
MANUALS One complete set of operators and maintenance manuals provided with each system ordered.

SYSTEM ELECTRONICS

A standard TENNELEC NIM Bin and modular electronics are incorporated into the LB 1000 System. This modular approach carries with it many years of reliability and proven performance and allows the user to conveniently isolate a problem, should the system ever fail to perform properly. Replacement modules can be sent by mail to quickly return the system to operation.

NIM BIN AND POWER SUPPLY Provides the proper voltages necessary for the operation of the modular electronics. Built into this instrument are:

- Power "on" and temperature "warning" indicator lights
- Line voltage filter
- Voltage monitoring test points
- Power "interrupt" indicator light
- Several spare slots for future improvements or options



PREAMPLIFIERS Low noise TENNELEC proportional counter preamplifiers distribute high voltage to their respective detector and amplify the charge input signal for transmission to the appropriate NIM amplifier.

GUARD AMPLIFIER/DISCRIMINATOR Amplifies the pulses from the guard detector preamplifier and generates a blocking pulse for each input signal that exceeds the discriminator.

SAMPLE AMPLIFIER/DUAL DISCRIMINATOR Amplifies the pulses from the sample detector preamplifier. Two discriminators are set; one above noise but sufficiently below typical beta energies with the second set above beta and below alpha energies. If both levels are exceeded, an output is generated indicating the detection of an alpha while if only the lower level is exceeded, an output is generated indicating the detection of a beta. All pulses are routed to the system triple counter and timer for acceptance or rejection by a guard detector blocking pulse.

COUNTERS AND TIMER A single NIM module containing three counters and a timer is provided with each system. Pulses from the alpha, beta and alpha plus beta outputs of the Sample Amplifier/Dual Discriminator are collected in separate counters or are rejected due to a guard detector blocking pulse.

FLOWMETER Is provided for adjusting the flow of P-10 gas to both detectors. The meter is calibrated in standard cubic feet per hour (SCFH) of air over the range 0.00 to 0.40 in increments of 0.05 SCFH. A gas tank regulator is also provided and fits all standard gas tanks.

DETECTOR BIAS SUPPLY Provides the high voltage to both detectors via independent outputs, routed through the preamplifiers. High voltage "on", "polarity" and "disabled" indicator lights are provided.

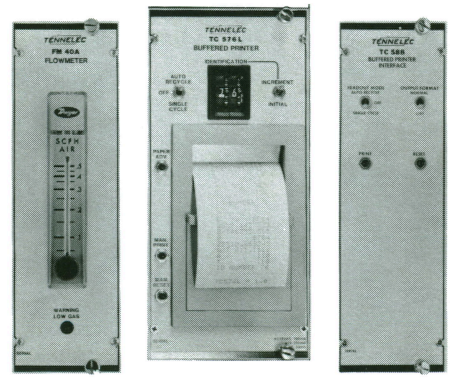
OPTIONAL EQUIPMENT AND ACCESSORIES

FM 40A Flowmeter with built-in gas pressure sensor, circuitry to indicate low gas pressure and disable system high voltage and gas filter.

TC 576L Buffered Printer This NIM printer interfaces to the system counter and timer to print the analysis results. (See FIGURE 1)

TC 588 Buffered Printer Interface Provides RS-232-C and 20mA outputs to interface to external printers, computers, microprocessors, etc. Is programmable for data formatting, headers, line delimeters, etc.

TC 589 Buffered Interface Provides IEEE Standard 488 and 20mA outputs to interface to external printers, computers, microprocessors, etc. Programmable.



Printed are:
* Sample ID number
* Time in hundreds of minutes
* A alpha total counts
* A/T alpha counts per minute
* 2S% 2 sigma of alpha counts in percent
* B Beta total counts
* B/T Beta counts per minute
* 2S% 2 sigma of beta counts in percent
* C Total alpha plus beta counts

Figure 1

TC 566A Time of Day/Time of Year Clock Provides the time of day (24 hour clock) and day of year (1 to 365) information to be printed or transferred to external devices.

Spare Windows 2.25" and 1.25" diameter windows either 500 $\mu gm/cm^2$ or 80 $\mu gm/cm^2$ thick are available. Other thickness windows are available on special request.

P-10 Gas Tennelec can provide scientific grade P-10 gas in several size cylinders.

TENNELEC 1980's

TENNELEC has long been known as a pioneer furthering the technology of nuclear pulse measurements.

Founded in 1960 by Edward Fairstein, one of the world's leading designers and authors in the nuclear electronics field, TENNELEC has continually strived to develop and provide the highest performance most reliable instrumentation available for nuclear research.

During 1960, when silicon semiconductor detectors were introduced, TENNELEC immediately set the standards of performance for the entire industry by designing and manufacturing the very first ultra-low-noise, charge-sensitive preamplifier. With the advent of sufficiently advanced transistor technology in 1964, TENNELEC developed and shipped the model TC 200 Linear Amplifier. The TC 200, using an "active element" pulse shaping technique, represented a radical departure from that which had previously been available in linear amplifiers. Built to TENNELEC's most stringent requirements for performance and reliability, the TC 200 quickly became the laboratory standard throughout the world, with many still in productive use today. Since that time, TENNELEC has continued to expand its line of instrumentation while maintaining the most rigid guidelines for performance and reliability.

The 1980's are here and so are the challenges every new decade seems to bring. New and better instrumentation is needed to meet the requirements of the scientific community. Costs, as never before, must be held at a minimum without sacrificing product quality and reliability. TENNELEC is meeting these challenges.

The instruments described in this brochure are but a few of TENNELEC's extensive product line. If you would like more information concerning these or any other TENNELEC instrument, please write or call us at the address and phone number listed below.

TENNELEC INC.

PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

10.0K 981

TENNELEC, INC. P.O. BOX 2560 601 TURNPIKE, OAK RIDGE, TENNESSEE 37831 2560 U.S.A.
TELEPHONE 615-483-8405 TWX 810 572 1018

LB 1000 PW
MANUAL PHOSWICH
LOW BACKGROUND
Alpha/Beta/Gamma
COUNTING SYSTEM

The Tennelec LB 1000-PW Manual Low Background Alpha/Beta/Gamma Counting System is an analytical instrument used to determine the gross radiation in low activity samples such as drinking water, air filters and environmental smears.

The LB 1000-PW System combines the convenience of a dual scintillator detector with the most reliable NIM electronics in the industry. Samples are presented to the shielded detector in carriers capable of holding 1 or 2 inch planchets from 1/16" to 5/16" deep. The linear processing electronics is all NIM modular for ease of calibration and service. Alpha, Beta and Gamma data is collected and displayed on the TC 535P triple counter and timer. Optional printer devices are available to provide hard copy reports of the data.

Standard Features of the LB 1000-PW System:

* Accomodates up to 2" diameter samples.
* Accomodates sample carriers upto 5/16" deep.
* Simultaneous low level alpha/beta/gamma detection.
* Ultra low background.
* Easy access detector slide assembly.
* Table top cabinets.

Optional Features for the LB 1000-PW System:

* Mobile cabinet.
* Time of Day/Time of Year Clock with battery back-up.
* TC 576L NIM printer with cpm and 2 sigma calculations.
* TC 588 buffered printer interface with KSR 43 Teletype.

DETECTOR ASSEMBLY

The LB 1000-PW utilizes a 2 inch diameter phoswich scintillation detector. The phoswich detector is composed of a calcium fluoride (CaF_2(Eu)) alpha/beta scintillator coupled to a sodium iodide (NaI(Tl)) gamma scintillator. The entire detector assembly is mounted for easy access and cleaning, enclosed within oxygen-free high conductivity (OFHC) copper and surrounded by four inches of low background virgin lead. The lead is a very effective shield for gamma and low energy "soft" cosmic rays. The OFHC copper efficiently absorbs lead x-rays produced inside the shield and thus provides an ultra low background condition for sample analysis.

Alpha and beta radiation is either totally or partially absorped by the thin calcium fluoride scintillator. Beta particles which penetrate this scintillator deposit the remainder of their energy in a quartz layer separating the two scintillator materials. The absorped energy in the CaF_2(Eu) scintillator is converted into visible light with a 0.9 microsecond decay time constant.

Gamma and cosmic radiation is absorped by the NaI(Tl) scintillator. This absorped energy is converted into visible light with a 0.23 microsecond decay time constant.

Light from the two scintillators is collected by a common photo-multiplier tube (PMT) and converted into a voltage pulse. The leading edge of the pulse characterizes the scintillator from which the light originated. This pulse is linearly amplified and processed by a pulse shape discriminator which separates the alpha and beta pulses from the gamma or cosmic pulses.

SAMPLE CHANGER

The manual sample changing mechanism is constructed from low background tool steel. Roller bearings are used to provide a smooth operation and opposing bearings assure repeatable sample positioning.

An interlock is included to prevent a total separation of the assembly which might result in mechanical damage. The same interlock allows for easy disassembly of the sample changer should decontamination be required.

Included with all LB 1000 Series systems are six sample carriers, six inserts for 1 inch diameter planchets, six inserts for 2 inch diameter planchets, fifty 1 x 0.1 inch stainless steel planchets and fifty 2 x 0.125 inch stainless steel planchets. Additional carriers, inserts and planchets are available.

SYSTEM LINEAR ELECTRONICS

The linear signal processing electronics for the LB 1000-PW System are modular and powered by a standard TENNELEC NIM Bin. This modular approach carries with it many years of reliability and proven performance and allows the user to conveniently isolate a problem should the system ever fail to perform properly. Replacement modules can be sent by mail to quickly return the system to operation.

NIM BIN AND POWER SUPPLY The bin and power supply provides the proper voltages necessary for the operation of the modular electronics. Built into this instrument are:

* Power "on" and temperature "warning" indicator lights
* Line voltage filter
* Voltage monitoring test points
* Power "interrupt" indicator light
* Spare slots for future expansion or options

PREAMPLIFIER A low noise preamplifier integrates the charge input signal from the phoswich detector into a voltage pulse to be applied to the NIM amplifier.

AMPLIFIER A linear shaping amplifier shapes and amplifies the preamp output for presentation to the pulse shape analyzer.

PULSE SHAPE ANALYZER This analyzer separates gamma events from alpha/beta events as seen by the phoswich detector. The separation technique is possible due to the difference in pulse risetimes resulting from the dissimilar scintillation decay characteristics of the phoswich detector.

PULSE HEIGHT ANALYZER Two pulse height or single channel analyzers are used to separate alpha from beta events as identified by the pulse shape analyzer.

DETECTOR BIAS SUPPLY A 3000 volt regulated high voltage power supply is used to bias the photomultiplier tube in the phoswich detector assembly. The bias supply features a digital indicator for accurate monitoring of the bias voltage.

OPTIONAL EQUIPMENT AND ACCESSORIES

MOBILE CABINET (LBM-01) Rugged compact wheeled cabinet allows the system to be relocatted with relative ease.

NIM PRINTER (TC 576L) This module will automatically print the time, alpha, beta and gamma count information using a thermal printer. A manual or auto incrementing two digit sample ID is printed at the beginning of each count cycle. In addition alpha and beta counts per minute (cpm) and 2 sigma counting uncertainties are calculated and printed.

BUFFERED INTERFACE (TC 588) This NIM modular interface provides a RS-232-C and 20 mA outputs to interface to external printers, computers, etc. Data delimiters and column headers are programmable. This unit can be supplied with a Teletype KSR 43 terminal/printer to provide hard copy printout.

TIME OF DAY/TIME OF YEAR CLOCK (TC 566A) This unit provides time of day (24 hour clock) and day of year (1 to 365) information. When used in conjunction with either of the printer options, the information will be printed along with collected count data. The TC 566A is supplied with rechargeable battery back-up for continued operation even with the NIM power supply inactive.

SYSTEM PERFORMANCE

DETECTOR BACKGROUND

2" Detector: alpha $\leq$ 0.2 cpm
beta $\leq$ 2.0 cpm

(Measured at TENNELEC in Oak Ridge, Tennessee)

DETECTOR EFFICIENCY

beta $\geq$40% for ^{90}Sr - ^{90}Y
alpha $\geq$35% for ^{210}Po
gamma $\geq$30% for ^{57}Co

ALPHA-BETA CROSSTALK

Counting ^{210}Po and ^{90}Sr, with ^{90}Sr adjusted for maximum efficiency and $\leq$1.5% crosstalk into the alpha channel, there will be a $\leq$10% crosstalk for ^{210}Po into the beta channel. Less than 1% of ^{57}Co gammas will fall into the beta range.

GAMMA RESOLUTION

<20% FWHM in NaI(Tl) guard crystal for ^{57}Co(122KeV).

SAMPLE COUNT RATE

500,000 cpm with <1.5% dead-time loss

TIMEBASE ACCURACY

0.002% crystal timebase

COUNTING TIME

Counting time per sample can be set at any number between 0.01 minutes and 90,000.00 minutes or from 0.1 to 900,000 seconds.

COUNT CAPACITY

Alpha, beta and gamma counters have a capacity of 9,999,999 counts.

PRESET

In addition to being able to preset time per sample, an independent preset count may be entered for one of the count channels.

ORDERING INFORMATION

SIZE AND WEIGHT

Electronics Cabinet
22"L x 20"W x 10"H; 43 lbs
55.9 cm x 50.8 cm x 25.4 cm; 19.5 kg

Sample Changer
22"L x 20"W x 30.0"H; 1230 lbs
55.9 cm x 50.8 cm x 76.2 cm; 558 kg

Total System Shipping Weight
1465 lbs; 664.5 kg

POWER

117V ± 10%, 60 Hz ± 3%; 1.050 amps
or 230V ± 10%, 50 Hz ± 3%; 0.525 amps

ENVIRONMENT

Operating temperature 10 - 40°C (50 - 104°F)
Relative humidity 20% to 90% non-condensing

WARRANTY

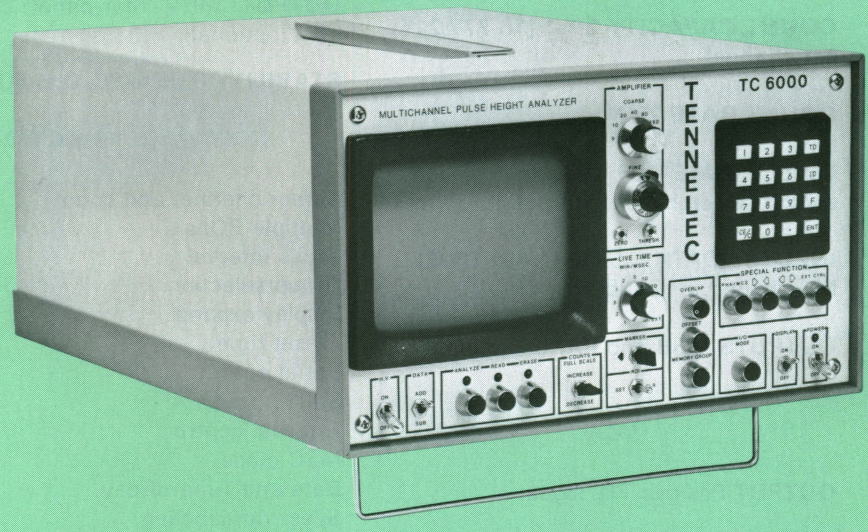
One year

MANUALS

One complete set of operators and maintenance manuals provided with each system ordered.

TENNELEC

TC 6000
Multichannel Pulse Height Analyzer



- **1024 channels, 2^{24}-1 capacity**
- **50 MHz, 1024 channel ADC**
- **25 MHz MCS**
- **Built-in preamplifier/amplifier**
- **500 to 1500 volt, 1 mA bias supply**
- **5" video display with alphanumerics**
- **Spectrum labeling, transfer, smoothing, and stripping**
- **ROI marker and integral**

DESCRIPTION

TENNELEC's TC 6000 Multichannel Pulse Height Analyzer is an economical, compact, rugged, reliable instrument designed for high performance data acquisition. The TC 6000 is well suited for nearly any spectral analysis application and yet very easy to use and operate.

Featuring a **1024 channel, 50 MHz ADC** and **1024 channels of memory,** data can be acquired either directly or through a **built-in preamplifier/amplifier.** The resulting spectrum is presented on a **crisp, high resolution, flicker-free 5" video display,** with linear and logarithmic display modes. A **digitally controlled marker** permits inspection of the contents of every memory channel and the creation of **multiple regions of interest. Channel number, channel counts, elapsed time, ROI integral,** and more are **alphanumerically displayed.**

A **500 to 1500 volt, 1 mA detector bias supply,** perfectly suited to NaI(Tl) detectors, is included in the TC 6000 MCA.

Multichannel Scaling (MCS) at a 25 MHz count rate is another standard feature of the TC 6000. Channel dwell times are selectable internally from 100 μsec to 1 second or externally.

A **sixteen (16) button keypad** allows the operator to **energy calibrate the MCA** and to perform **spectrum labelling, transfers, smoothing and stripping.** A time-of-day, time-of-year clock as well as an automatic recycle program is also included and programmable via this keypad.

The TC 6000 includes, as standard, an **RS-232-C interface** with **selectable baud rate** and **full handshake capability** for connection to a wide range of serial printers, computers, etc.

In applications involving connection to computers, an **external control mode** may be activated to allow the computer to control both data acquisition and readout.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

SPECIFICATIONS

GENERAL

TYPE AC line powered with carrying handle

MEMORY 1024 channels, solid state

CAPACITY 2^{24}-1, (16,777,215) per channel

ACQUISITION MODE Pulse height analysis, add or subtract or multichannel scaling

TIME BASE 5.24 MHz, crystal controlled. Preset live time from 0.1 to 1000 minutes with front-panel switch, or 0.1 to 1000 msec in MCS mode.

MEMORY GROUPS Full, halves, or quarters, selectable

AMPLIFIER

TYPE Voltage sensitive preamplifier/amplifier for use with NaI(Tl) PMT anode signals.

COARSE GAIN 5 to 320 in steps of 2.

FINE GAIN X1 to X3, 10-turn Helipot.

SHAPING TIME 1 μsec, double R-C shaping

ADC

TYPE Peak detecting. Wilkinson

CLOCK FREQUENCY 50 MHz

CONVERSION GAIN 256, 512, or 1024, channels, depending on memory group selection.

LINEARITY Integral: <±0.1% over top 98% of range. Differential: <±1% over top 98% of range.

INPUT RANGE 0 to 8 volts

TEMP STABILITY
Gain: <±0.01%/°C, 0 to 50°C
Zero Level: <±0.01%/°C, 0 to 50°C

ZERO LEVEL Front-panel control, sets zero intercept.

THRESHOLD Front-panel control superseded by SCA lower lever discriminator.

INPUTS Amplifier or direct, rear-panel switch selectable.

GATE Complementary TTL signal, gates off ADC.

MCS

COUNT CAPACITY 2^{24}-1 (16,777,215) per channel

COUNT RATE 25 MHz

DWELL TIME 100 μsec to 1 second, switch selectable or external.

INPUTS DATA, EXTERNAL DWELL, Mossbauer compatible.

OUTPUTS MSB and RAMP (optional)

SCA

OUTPUT Positive TTL signal

ULD and LLD Adjustable full scale from 0 to >8 volts

DISPLAY

TYPE 5" video, black and white

RESOLUTION 1 part in 256

COUNTS FULL SCALE 256 to 16,777,215 in binary increments or logarithmic.

ROI Moveable marker allows selection of up to 512 ROI regions.

EXPAND Displays 128 channels on either side of cursor. Marker is moveable in either direction and data may be acquired in the expand mode.

TEXT Alphanumeric character generator displays the following information:

- system status
- cursor channel (energy) and count
- elapsed live time/live time remaining
- memory group
- ROI integral
- full scale range
- data
- time-of-day
- spectrum I.D. code

OUTPUT Video output for driving external monitor.

HIGH VOLTAGE

RANGE 500-1500V, continuously adjustable by 10 turn potentiometer (Helipot, rear panel).

CURRENT 1 mA maximum, 1 watt maximum power.

OUTPUT MHV rear-panel connector. (SHV optional).

STABILITY 0.05%/°C, 0 to 50°C

SOFTWARE FUNCTIONS

Cursor channel and count
Multiple ROI's
Gross integral
Group selection
Display expand
Preset time
Serial output
Serial input
External control
MSC mode
Date and Time-of-day
Spectrum labeling
Spectrum transfer
Spectrum stripping
Spectrum smoothing
Programmable recycle
Energy calibration

INPUT/OUTPUT

DATA OUTPUT RS-232-C. Serial input/output for data and external control; X-Y analog output for plotters or strip chart recorders.

VIDEO Composite video for external monitor. Optional RF modulator for operating standard TV.

SCA OUTPUT Positive TTL output for driving MCS input.

MCA INPUT ADC and amplifier inputs, switch selectable.

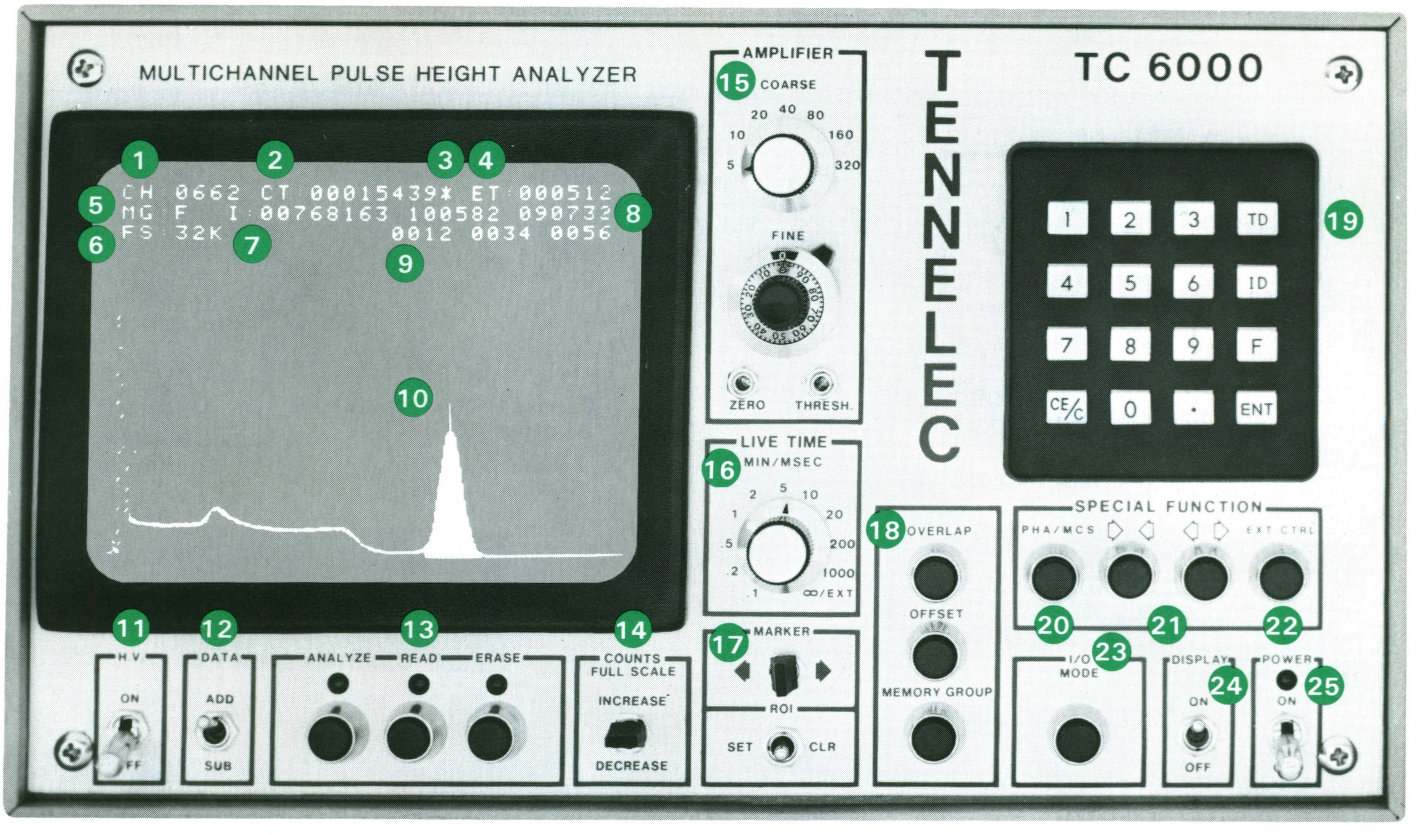
GATE Complementary TTL signal gates off ADC.

MCS INPUT TTL, rear-panel BNC connector.

MSB Most significant bit output via rear-panel BNC. (optional)

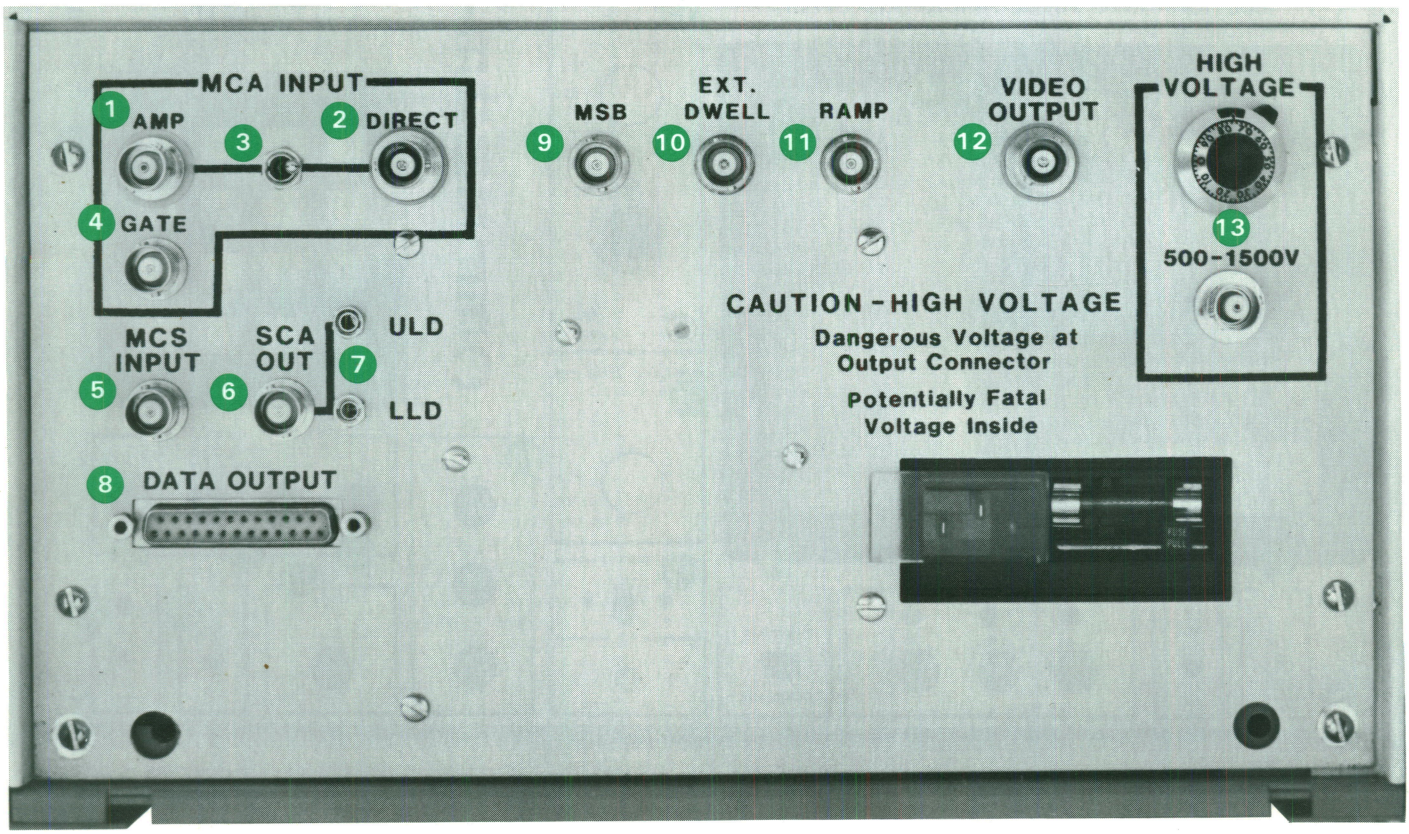
RAMP MCS analog address ramp output, 0 to 5 volts. (optional)

EXTERNAL DWELL TTL input controls dwell period when switch is at ∞/EXT.



1. Marker channel number or Marker energy when calibrated
2. Marker channel counts
3. "*" indicates marker is within a region of interest
4. Elapsed live time or live time remaining when "analyze" pushbutton depressed during analysis
5. Memory group selected
6. Vertical full scale range
7. Region of interest, ROI, integral
8. Date: October 5, 1982 and Real Time: 09:07:32
9. Spectrum labeling: three, four-digit fields
10. High resolution 5" video display with external video output provided
11. Built-in detector high voltage on/off locking switch
12. Data add/subtract switch
13. Analyze, Read and Erase pushbuttons with LED indicators
14. Counts full scale increase/decrease toggle switch
15. Built-in amplifier coarse and fine gain controls
16. Live time (minutes) for pulse height analysis and dwell time (milliseconds) for multichannel scaling
17. Digitally controlled marker toggle switch with multiple ROI set/clear switch
18. Spectral comparison, display offset and memory group selection pushbuttons
19. Keypad provides
    - Date and time-of-day real time clock
    - Spectrum labeling
    - Programmable recycle
    - Spectrum smoothing
    - Spectrum stripping
    - Spectrum transfer
    - Energy calibration
20. Pulseheight analysis/Multichannel scaling mode pushbutton
21. Display expansion and contraction pushbuttons
22. External control via RS-232-C interface
23. Input/Output mode selection pushbutton
24. Display on/off switch
25. Power on/off locking switch

TC 6000 Multichannel Pulse Height Analyzer



1. BNC input to built-in preamplifier/amplifier
2. BNC input direct to ADC
3. Selection switch for amp or direct input
4. BNC input accepts TTL signals to gate off the ADC
5. BNC input for multichannel scaling
6. BNC single channel output directly compatible with MCS input
7. Upper level and lower level discriminator controls for SCA; 15 turn potentiometers
8. RS-232-C serial input/output for data and external control
9. BNC output of most significant bit for Mossbauer drivers (optional)
10. BNC input for external control of MCS channel dwell time
11. BNC output of 0 to 5 volt ramp for Mossbauer drivers (optional)
12. BNC output for external video displays
13. Ten turn potentiometer and MHV connector supplies detector high voltage

MECHANICAL & ELECTRICAL

DIMENSIONS 6.5"H x 11"W x 16"D (165 mm x 280 mm x 406 mm)

LINE VOLTAGE 100/120 or 220/240 VAC, universal line cord and voltage selector.

LINE FREQUENCY 50 or 60 Hz factory set.

TEMPERATURE 0 to 50°C.

HUMIDITY Up to 90%, non-condensing.

WEIGHT (SHIPPING) 26 lbs. (11.8 kg)
(NET) 20 lbs. (9.1 kg)

OPTIONS AND ACCESSORIES

Most Significant Bit (MSB) and ramp control outputs for Mossbauer drivers.

RF modulator for TV display.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

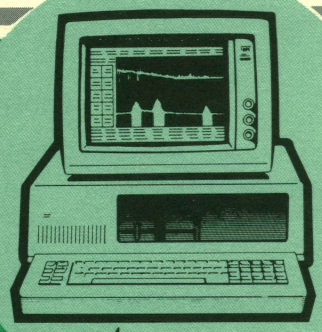
TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.

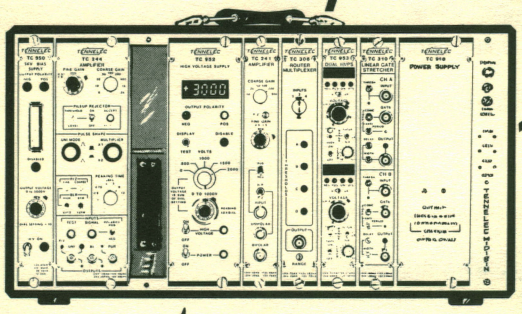
TC 6000 10.0K 1283

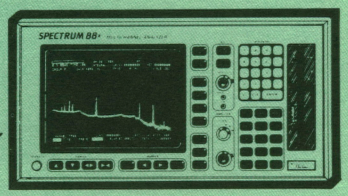
TENNELEC

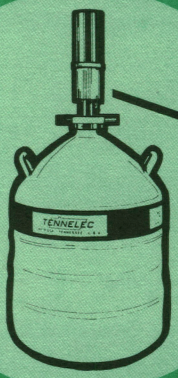
NUCLEAR INSTRUMENTATION MODULES

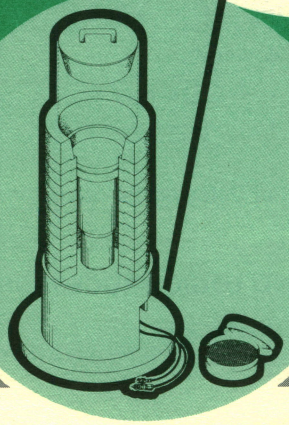
YOUR
KEY TO
COUNTING AND
SPECTROSCOPY
SYSTEMS











DOMESTIC
NIM
PRICE LIST

JANUARY
1987

TENNELEC, INC.
601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone (615) 483-8405 TWX 810-572-1018
FAX (615) 483-5891

TENNELEC

REPRESENTED
WORLDWIDE

TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

PREAMPLIFIERS

Model No.	Description	NIM Width	Price (US $)
TC 145	Scintillation Detector Preamplifier		$225
TC 148A	G-M Tube Preamplifier		165
TC 154	Photomultiplier Tube Base	12 pin base	195
TC 154A	PM Tube Base with built-in preamplifier	12 pin base	325
TC 155	Photomultiplier Tube Base	14 pin base	195
TC 155A	PM Tube Base with built-in preamplifier	14 pin base	310
TC 170	FET Spectroscopy Preamplifier (Lo Cap)		675
TC 171	FET Spectroscopy Preamplifier (Hi Cap)		675
TC 174	FET Preamplifier for general purpose		395
TC 175	FET Preamplifier for proportional counters		650
TC 178	Quad Preamplifier		1,425
TC 178P	Quad Pulser	1 NIM	775

AMPLIFIERS

	Model No.	Description	NIM Width	Price (US $)
	TC 202BLR	Spectroscopy Amplifier 0.53 μsec to 2.4 μsec time constant	1 NIM	$925
	TC 205A	Research Spectroscopy Amplifier	2 NIM	1,495
	TC 215	Delay Amplifier 0.25 μsec to 4.75 μsec delay	1 NIM	555
	TC 240	General Purpose Amplifier 2.0 μsec peaking time	1 NIM	475
	TC 241	Spectroscopy Amplifier 1.0, 3.0, and 6.0 μsec peaking times	1 NIM	525
	TC 241-02	2.0 μsec Unipolar delay option		135
	TC 242	Spectroscopy Amplifier 1,2,4,8,16,24 μsec peaking times	1 NIM	1,095
	TC 242-02	2.0 μsec Unipolar delay option		135
	TC 243	Spectroscopy Amplifier, triangular/gaussian shaping	1 NIM	1,295
NEW!	TC 244	Spectroscopy Amplifier, w/Internal Pileup Rejector, triangular/gaussian shaping	2 NIM	1,595
	TC 244-02	2.0 μsec Unipolar delay option		175
	TC 246	Linear Amplifier and Single Channel Analyzer	1 NIM	850
	TC 247	Dual Amplifier 2.0 μsec peaking times	1 NIM	850
NEW!	TC 248	Fast/Slow Amplifier	1 NIM	850
	TC 248-02	2.0 μsec Unipolar delay option		135
	TC 252	Biased Amplifier	1 NIM	595
	TC 253	Dual Sum and Invert Amplifier	1 NIM	350

THE ORIGINALS!

ALPHA SPECTROMETERS

Model No.	Description	NIM Width	Price (US $)
TC 256	Alpha Spectrometer (without detector)	2 NIM	$1,795
TC 256-500 CE-SNA	Alpha Spectrometer with 500 mm² "See No Alpha" Cleanable Electrode detector	2 NIM	2,395
TC 256-600 CE-SNA	Alpha Spectrometer with 600 mm² "See No Alpha" Cleanable Electrode detector	2 NIM	2,550
TC 256-1000 CE-SNA	Alpha Spectrometer with 1000 mm² "See No Alpha" Cleanable Electrode detector	2 NIM	2,895
TC 257	Alpha Spectrometer - 2" sample size (without detector)	3 NIM	2,295
TC 257-2000 CE-SNA	Alpha Spectrometer with 2000 mm² "See No Alpha" Cleanable Electrode detector	3 NIM	4,300

NOTE: Tennelec manufactures a complete line of Silicon Surface Barrier Detectors for use in the Model TC 256, TC 257, or other spectroscopy systems. Contact the factory for additional information.

LINEAR GATES, COINCIDENCE AND LOGIC PROCESSORS

	Model No.	Description	NIM Width	Price (US $)
	TC 306	Linear Router and Multiplexer	1 NIM	$895
	TC 307	Linear Gate	1 NIM	425
	TC 308	Dual Linear Gate	1 NIM	695
NEW!	TC 309	Linear Gate and Stretcher	1 NIM	650
NEW!	TC 310	Dual Linear Gate and Stretcher	1 NIM	1,195
	TC 404A	Multipurpose Coincidence	2 NIM	495
	TC 410A	Delay and Gate Generator	1 NIM	475
	TC 412A	Nanosecond Delay, 1 to 63 nanoseconds	1 NIM	375

CABLES, CONNECTORS, TERMINATORS

Preamplifier Signal and Power Cable Amphenol 17-20090 to Amphenol 17-10090

Model No.	Description	Price (US $)
NC-OPA-12	Preamplifier Signal and Power Cable, 12 feet length Amphenol 17-20090 to Amphenol 17-10090 Connectors (For TENNELEC Preamplifiers with S/N <2000)	$75
NC-PAC-10	Preamplifier Signal and Power Cable, 10 feet length (For TENNELEC Preamplifiers with S/N >2000)	65
ADT-1	Preamp power adapter	20
ADT-2	Preamp power adapter with Test Input and Energy Output BNC	35

TEES, TERMINATORS, AND ADAPTERS

ATT-10	X10 Amplifier Input Attenuator	$35
NC-TEE	BNC Tee Connector (one male, two female)	10
NC-TERM-50	BNC Terminator, 50 ohms	15
NC-TERM-93	BNC Terminator, 93 ohms	15
NC-MTB	Microdot (female) to BNC (male) adapter	50
NC-BTM	BNC (female) to Microdot (male) adapter	50
NC-LTEE	LEMO Tee Connector (one male, two female)	35
NC-LTERM	LEMO Terminator, 50 ohms	25
NC-BTB	BNC (female) to BNC (female) adapter	15
NC-BTL	BNC (male) to LEMO (female) adapter	25
NC-LTB	LEMO (male) to BNC (female) adapter	25
NC-BTM-VF	BNC (female) to Microdot (male) Vacuum feed through connector	70
NC-MTM-VF	Microdot (female) to Microdot (male) Vacuum feed through connector	65

INSTRUMENT CABINET

CAB-8	Instrument Cabinet, 8¾" x 19" Panel, 21½" Deep	$395

SIGNAL CABLES

RG-58, 50 ohm impedance cable with BNC-BNC Connectors

NC-581-0.5	0.5 foot long	$15	NC-581-06	6 feet long	15
NC-581-01	1 foot long	15	NC-581-12	12 feet long	15
NC-581-02	2 feet long	15			

RG-62, 93 ohm impedance cable with BNC-BNC Connectors

NC-621-0.5	0.5 foot long	$15	NC-621-06	6 feet long	15
NC-621-01	1 foot long	15	NC-621-12	12 feet long	15
NC-621-02	2 feet long	15			

RG-58, 50 ohm impedance cable with LEMO-LEMO Connectors

NC-58L-0.5	0.5 foot long	$30	NC-58L-06	6 feet long	30
NC-58L-01	1 foot long	30	NC-58L-12	12 feet long	30
NC-58L-02	2 feet long	30			

RG-174, 50 ohm impedance cable with LEMO-LEMO Connectors

NC-174L-0.5	0.5 foot long	$30	NC-174L-06	6 feet long	30
NC-174L-01	1 foot long	30	NC-174L-12	12 feet long	30
NC-174L-02	2 feet long	30			

RG-174, 50 ohm impedance cable with Microdot-Microdot Connectors

NC-174M-0.2	2 inch long	$45	NC-174M-06	6 feet long	45
NC-174M-01	1 foot long	45	NC-174M-12	12 feet long	45
NC-174M-02	2 feet long	45			

RG-174, 50 ohm impedance cable with Microdot-BNC Connectors

NC-174MB-01	1 foot long	$70	NC-174MB-06	6 feet long	70
NC-174MB-02	2 feet long	70	NC-174MB-12	12 feet long	70

NaI (Tl) DETECTORS

Standard Right Circular Cylinder, Integral Crystal-PMT Assembly (all units fit TC 155 & TC 155A)

Model No.	Description	NIM Width	Price (US $)
	Diameter x Height		
TD 25 S 25	1" x 1" NaI(Tl) Crystal on 2" Photomultiplier Tube		$450
TD 38 S 38	1½" x 1½" NaI(Tl) Crystal on 2" Photomultiplier Tube		525
TD 51 S 51	2" x 2" NaI(Tl) Crystal on 2" Photomultiplier Tube		575
TD 76 S 76	3" x 3" NaI(Tl) Crystal on 3" Photomultiplier Tube		1,495

Standard Well In Right Circular Cylinder (all units fit TC 155 and TC 155A)

	Diameter x Height		
TD 51 SP 51	2" x 2" NaI(Tl) Crystal with 1" x 1.5" deep well, 2" PMT		$650
TD 76 SP 76	3" x 3" NaI(Tl) Crystal with 1" x 2.0" deep well, 3" PMT		1,595

THIN WINDOW X-RAY DETECTORS, INTEGRAL CRYSTAL-PMT

(All X-Ray Detectors fit TC 154 and TC 154A)

	Diameter x Height		
TD 25 SX 1	1" dia. x 1mm thick NaI(Tl) Crystal with 5 mil Be entrance window, 1.5" PMT;		$795
TD 38 SX 2	1½" dia. x 2mm thick NaI(Tl) Crystal with 5 mil Be entrance window, 1.5" PMT;		895

GAS DETECTORS

TD 2902	0.6" diameter GM Tube and Stand		$110
TD 2903	1.4" diameter GM Tube and Stand		160
TD 2904	0.5" diameter Proportional Counter with SHV connector		1,195
TD 2905	1.0" diameter Proportional Counter with SHV connector		1,295

ACCESSORIES

TV-1A	Vacuum Chamber, front access		$495
TC 2902G	Lead Shield for 1" diameter GM Tube or Proportional Counter down-looking with planchet holder base.		850
TC 2902C	Lead Shield for 1" or 2" diameter NaI (Tl) detector, up-looking, solid top plug.		745
TC 2902W	Lead Shield for 1" or 2" diameter NaI (Tl) well detector, up-looking, top plug with access hole.		745
TC 2903C	Lead Shield for 3" diameter NaI (Tl) detector, up-looking, solid top plug.		1,195
TC 2903W	Lead Shield for 3" diameter, NaI (Tl) well detector, up-looking, top plug with access hole.		1,195

BLANK MODULES

NIM-B1W	Blank NIM Module	1 NIM	$60
NIM-B2W	Blank NIM Module	2 NIM	65
NIM-B3W	Blank NIM Module	3 NIM	70
NIM-B4W	Blank NIM Module	4 NIM	75

BLANK FRONT PANELS

NIM-BP1	Blank NIM Front Panel	1 NIM	$20
NIM-BP2	Blank NIM Front Panel	2 NIM	20
NIM-BP3	Blank NIM Front Panel	3 NIM	25
NIM-BP4	Blank NIM Front Panel	4 NIM	25

DISCRIMINATORS AND SINGLE-CHANNEL ANALYZERS

	Model No.	Description	NIM Width	Price (US $)
	TC 450	Single-Channel Analyzer	1 NIM	$425
	TC 451	Constant Fraction Timing Single-Channel Analyzer	1 NIM	695
NEW!	TC 452	Quad Single-Channel Analyzer with DVM	1 NIM	1,095
	TC 453	100 MHz Constant Fraction Discriminator	1 NIM	950
	TC 454★	200 MHz Quad Constant Fraction Discriminator with gating	1 NIM	1,995
	TC 455★	200 MHZ Quad Constant Fraction Discriminator without gating	1 NIM	1,995

COUNTERS, TIMERS, CONTROLLERS, PRINTER AND RATEMETERS

	TC 525	1 MHz Linear Ratemeter	1 NIM	$550
	TC 526	100 MHz Linear Ratemeter	1 NIM	650
	TC 527	100 MHz Log/Lin Ratemeter	2 NIM	1,050
	TC 529	Alarm Control	1 NIM	695
	TC 530-01	Buffered Parallel output option (for TC 532, TC 533 and TC 534)		275
	TC 531	100 MHz Counter, non-printing	1 NIM	475
	TC 532	100 MHz Counter, 7 decade	2 NIM	495
	TC 533	100 MHz Counter, printing	2 NIM	725
	TC 534	100 MHz Counter and Timer, printing	2 NIM	995
	TC 535P	Multiscaler, 3 Counters (85 MHz) and 1 Timer, printing	3 NIM	1,495
	TC 536	100 MHz Counter and Timer, non-printing	1 NIM	750
	TC 541A	Timer, Recyclable, non-printing	1 NIM	450
	TC 546P	Counter, printing	1 NIM	695
	TC 547P	Timer/Counter, printing	1 NIM	895
	TC 566A	Time of Day/Time of Year Clock, printing	1 NIM	850
	TC 576	Buffered Printer	3 NIM	1,595
	TC 576-01	Pack of 3 rolls of paper for the TC 576 printer		15
	TC 588	Buffered Printout Control/Interface (RS-232-C and 20mA)	2 NIM	1,125
	TC 588-01	RS-232-C Cable, 10 feet long		75
	TC 588-02	20mA Cable, 10 feet long (Also usable with TC 589)		35
	TC 589	Buffered Interface (IEEE standard 488 and 20mA)	2 NIM	1,125
	TC 589-01	IEEE 488 Cable, 12 feet long		150
	TC 599	Howler, audible ratemeter accessory	1 NIM	350

PULSER AND TIME-TO-AMPLITUDE CONVERTERS

NEW!	TC 813	Pulser	1 NIM	$395
NEW!	TC 862	Time-to-Amplitude Converter (TAC)	1 NIM	975
NEW!	TC 863	TAC/Single Channel Analyzer with DVM	2 NIM	1,295
NEW!	TC 864	TAC/Biased Amplifier	2 NIM	1,795

NIM BINS AND POWER SUPPLIES

	TB3	NIM bin (parallel wired power distribution)	12 NIM	$495
	TC 911	Power Supply for TB3, ±12V, ±24V		595
NEW!	TC 911 *Turbo*	Super Power Supply for TB3, ±6V, ±12V, ±24V, 400+ watts		1,995
	TC 911-6	Power Supply for TB3, ±6V, ±12V, ±24V		1,095
	MB1/TC 909	Minibin and Power Supply, ±12V, ±24V	6 NIM	950
	MB2/TC 910	Midibin and Power Supply, ±12V, ±24V	10 NIM	995
	TB3/TC 911	NIM Bin and Power Supply, ±12V,±$^{\Delta}$24V	12 NIM	925
NEW!	TB3/TC 911 *Turbo*	NIM Bin and Super Power Supply for ±6V, ±12V, ±24V, 400+ watts	12 NIM	2,395
	TB3/TC 911-6	NIM Bin and power Supply, ±6V, ±12V, ±24V	12 NIM	1,450
NEW!	BG OPTION	Bin Gate Option for TB3, TB3/TC 911, TB3/TC 911 *Turbo*, or TB3/TC911-6	(additional)	+150

PREAMPLIFIER, HIGH VOLTAGE AND DETECTOR BIAS SUPPLIES

	TC 930A	Portable Power Supply for Preamps, Modules, Bins		$650
	TC 948	High Voltage Power Supply, 0 to + 1500V, 1mA	1 NIM	650
	TC 950	Detector Bias Supply, 0 to ± 5kV, 100μA	1 NIM	695
	TC 952	High Voltage Power Supply with DVM, 0 to ± 3kV, 10mA	2 NIM	995
NEW!	TC 953	Dual Detector Power Supply, 0 to ± 1kV with DVM	1 NIM	1,050
NEW!	TC 954	Detector Power Supply, 0 to ± 1kV with DVM	1 NIM	650

★ *Requires ± 6 volts*

HIGH VOLTAGE CABLES

Model No.	Description	NIM Width	Price (US $)
RG-59, 75 ohm impedance H.V. Cables			
NC-592-02	2 feet long, BNC to MHV Connectors		$30
NC-593-06	6 feet long, MHV to MHV Connectors		25
NC-593-12	12 feet long, MHV to MHV Connectors		25
NC-594-02	2 feet long, BNC to SHV Connectors		35
NC-595-06	6 feet long, SHV to SHV Connectors		45
NC-595-12	12 feet long, SHV to SHV Connectors		45
NC-596-06	6 feet long, SHV to MHV Connectors		45
NC-596-12	12 feet long, SHV to MHV Connectors		45

MISCELLANEOUS CABLES AND NIM MODULE EXTENDER

NC-ODA-2	2 foot Data Acquisition Cable, Connectors-Amphenol 552929-1		$45
NC-SBCA-05	5 foot cable, from module slot in TB 3 to PG-13 of slave bin.		55
NC-EXC-4	4 foot module extender cable, Connectors-Amphenol 202516-3 and 202515-5.		85
NC-NIM-EXT	NIM Module Extender	1 NIM	325

SPECIAL LENGTH CABLES
(Specify length)

NC-OPA-XX-S	Preamplifier Signal and Power Cable, Amphenol 17-20090 to Amphenol 17-22090 Connectors	$75+1.00/ft
NC-PAC-XX-S	Preamplifier Power Cable for TC 170, TC 171, and TC 174 Preamplifiers	65+1.00/ft
NC-581-XX-S	RG-58, 50 ohm impedance Cable with BNC-BNC Connectors	15+0.50/ft
NC-621-XX-S	RG-62, 93 ohm impedance Cable with BNC-BNC Connectors	15+0.50/ft
NC-592-XX-S	RG-59, 75 ohm impedance H.V. Cable with BNC-MHV Connectors	30+0.50/ft
NC-593-XX-S	RG-59, 75 ohm impedance H.V. Cable with MHV-MHV Connectors	25+0.50/ft
NC-594-XX-S	RG-59, 75 ohm impedance H.V. Cable with BNC-SHV Connectors	35+0.50/ft
NC-595-XX-S	RG-59, 75 ohm impedance H.V. Cable with SHV-SHV Connectors	45+0.50/ft
NC-596-XX-S	RG-59, 75 ohm impedance H.V. Cable with SHV-MHV Connectors	45+0.50/ft
NC-ODA-XX-S	Data Acquisition Cable, Amphenol 552929-1 Connectors	45+0.50/ft
NC-SBCA-XX-S	Slave Bin Cable Connects Module Slot in TB3 with PG-13 of slave bin	55+1.00/ft
NC-EXC-XX-S	Module Extender Cables Amphenol 202516-3 and 202515-5 Connectors	85+1.00/ft
NC-58L-XX-S	RG-58, 50 ohm impedance Cable with LEMO-LEMO Connectors	30+0.50/ft
NC-174L-XX-S	RG-174, 50 ohm impedance Cable with LEMO-LEMO Connectors	30+0.50/ft
NC-174M-XX-S	RG-174, 50 ohm impedance Cable with Microdot-Microdot Connectors	45+0.50/ft
NC-174MB-XX-S	RG-174, 50 ohm impedance Cable with Microdot-BNC Connectors	75+0.50/ft

Shipping Methods: We normally ship by Motor Freight or UPS. Other shipping methods will be followed at your request.

Warranty: TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices: All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

Payment Terms: 1%10, Net 30 days.

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Telephone (615) 483-8405 TWX 810-572-1018
FAX (615) 483-5891

TENNELEC

TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

TENNELEC REPORTS

TENNELEC'S OWN HIGH PURITY GERMANIUM DETECTOR

TENNELEC REPORTS

CP Series High Purity Coaxial P-Type Germanium Detector Systems

As many of you may know, Tennelec has been an international supplier of high purity germanium material. This material is used in high resolution high purity germanium detectors.

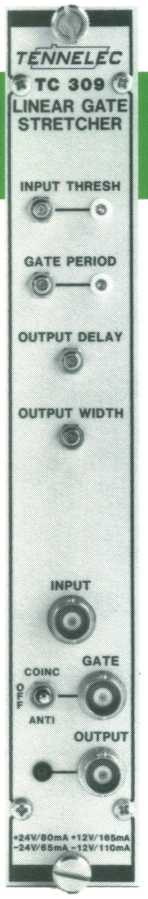
Now Tennelec has introduced its own High Purity Germanium Detectors.

Each detector consists of a high purity germanium detector, uniline vacuum cryostat, liquid nitrogen dewar, charge-sensitive preamplifier, and cable pack.

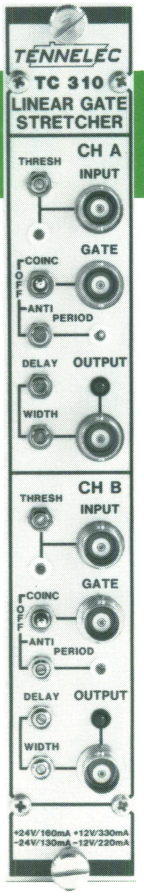
A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and **internally** disables the high voltage when the temperature rises to an unsafe level. An on-board LED illuminates red when the disable circuit is activated. This same LED illuminates green when the system is cold and bias is applied.

This sensing circuit works automatically, 24 hours a day, with NO external cabling necessary! No longer can your expensive investment be ruined because someone forgot to hook up a cable. (Or connected it incorrectly!)

A High Count Rate LED is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier.



TC 309



TC 310

NEW

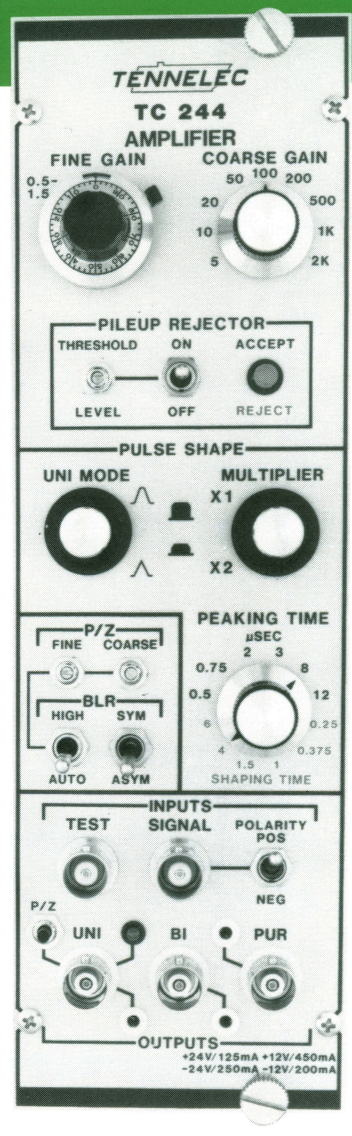
TC 309 Linear Gate and Stretcher; TC 310 Dual Linear Gate and Stretcher

Tennelec's new TC 309 Linear Gate and Stretcher and TC 310 Dual Linear Gate and Stretcher are new additions to the broad line of Tennelec instruments. These units combine the basic functions of a linear gate and a pulse stretcher with superb linearity and temperature stability.

The TC 309 and TC 310 are totally dc-coupled and feature trailing edge pulse pileup rejection to minimize peak shifts. The output pulse is adjustable for both width and delay.

A front-panel LED output indicator illuminates when an event is output from the unit, thereby providing positive visual indication of the units operation.

CHANGING THE SHAPE OF THINGS



TC 244 Amplifier/Pileup Rejector Live Time Corrector

For years, most amplifiers used in spectroscopy measurement have utilized a circuitry which produces a semi-gaussian shaped pulse as shown in figure 1. This type of amplifier shaping had the advantage of both simplicity and flexibility. Its disadvantage, however, is that it is **not** optimum for either the best resolution or high throughput.

As described by Goulding and Landis,[1] other waveforms are superior to the gaussian waveform but the circuitry required to produce these other waveforms has been, in the past, both complex and unstable.

Based on research conducted at the University of California at Berkeley,[2] Tennelec now offers the TC 244 Amplifier/Pileup Rejector which is stable, improves resolution, and increases throughput by nearly 35%.

The advantages of triangular shaping are (1) the leading edge is less sharp than its gaussian counterpart resulting in lower noise and better resolution and (2) the trailing edge returns to the baseline more quickly allowing faster pulse processing (see Fig. 1).

In addition to the triangular shaping, the TC 244 has an exclusive internal pulse pileup rejector that allows much higher throughput because the incoming pulses do not have to completely return to the baseline to be inspected for pileup (see Fig. 2).

We invite you to see the improvement in your system for yourself. Your local sales representative will be more than happy to provide you with a unit for a 14 day evaluation. Write or call today.

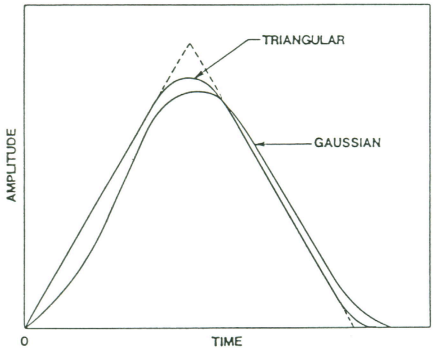


Fig. 1

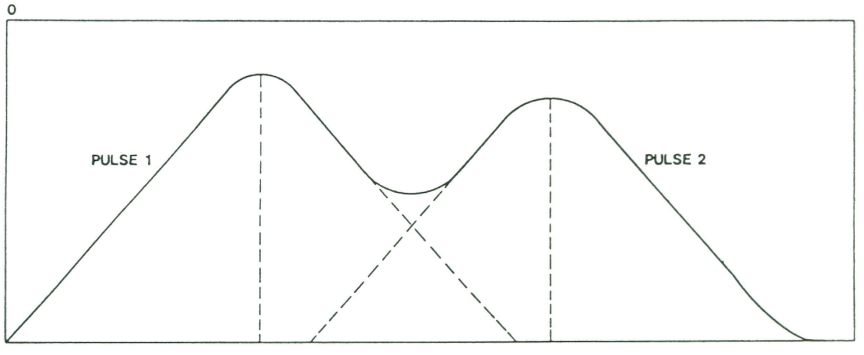


Fig. 2

[1] F. S. Goulding and D. A. Landis, "Signal Processing for Semiconductor Detectors", in IEEE Transactions on Nuclear Science, Vol. NS-29, No. 3. 1128 (June 1982)

[2] F. S. Goulding, D. A. Landis and N. W. Madden, "Design and Philosophy of High-Resolution Rate and Throughput Spectroscopy Systems", in IEEE Transactions on Nuclear Science, Vol. NS-30, 301 (February 1983)

EVOLUTIONARY

LB 5100 Series III Low Background Alpha/Beta/Gamma Counting Systems

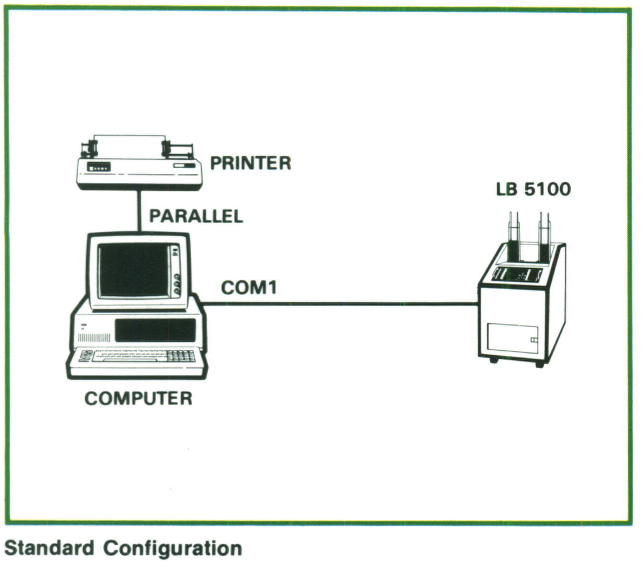
The evolutionary process requires the experience attained from over 500 installed systems.

The new Tennelec LB5100 Series III Low Background Alpha/Beta/Gamma Counting Systems are indeed evolutionary.

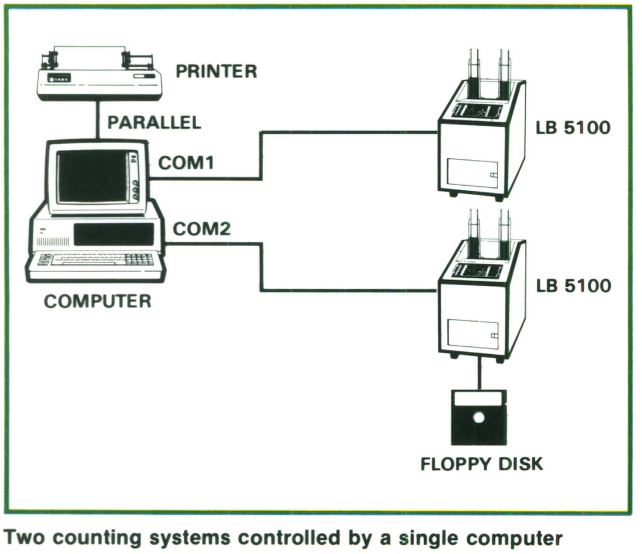
The features included in this new system are:

- Compact Mobile Cabinet
- Optional computer control for dedicated or distributed data processing
- Sophisticated microprocessor based controller for providing programmable output formats

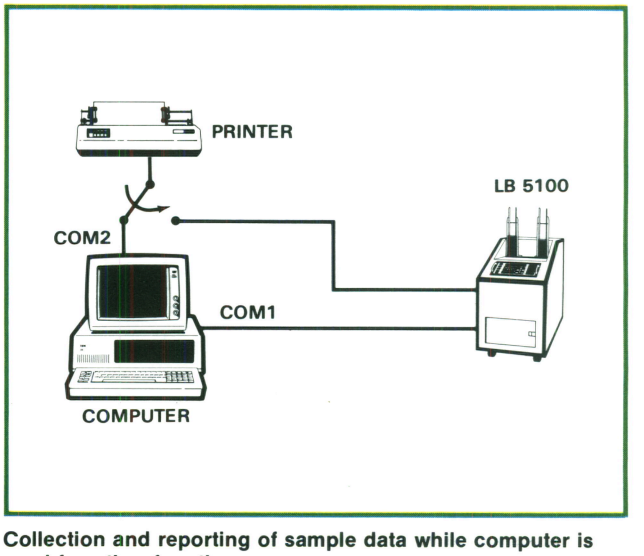
Because we have distributed processing, the optional computer need not be dedicated to your counting system. This frees your computer for other calculations. With the use of The Nucleus Multichannel Analyzer (MCA) card which plugs into the computer, the computer can act as both a controller for the Series III counting system and an MCA simultaneously. Below are just some of the configurations which the new Series III can take:



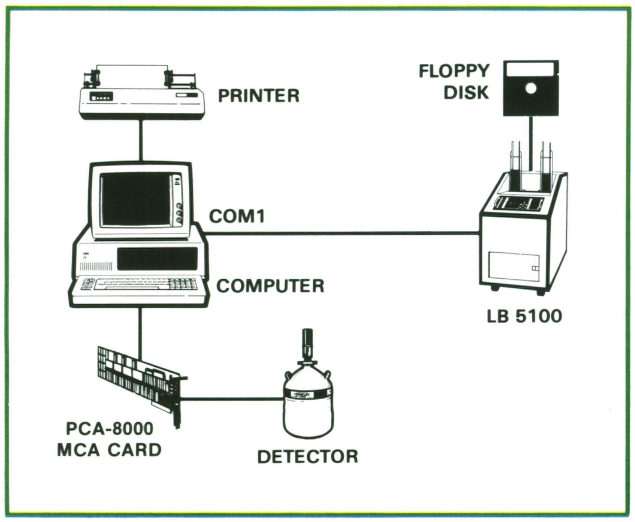
Standard Configuration



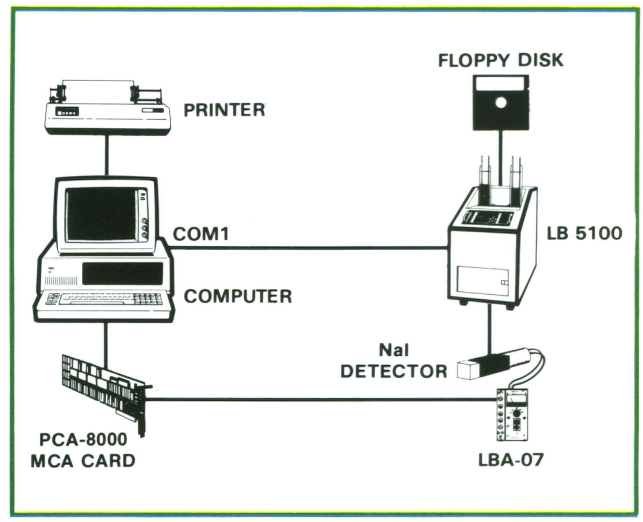
Two counting systems controlled by a single computer



Collection and reporting of sample data while computer is used for other functions.

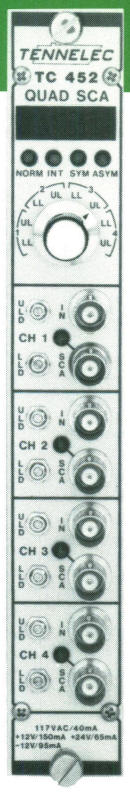


Simultaneous control of both Series III and a germanium detector spectroscopy system.



Simultaneous control of both Series III and a sodium iodide (NaI) counting system.

MULTIPLE SCA



TC 452 Quad Single Channel Analyzer

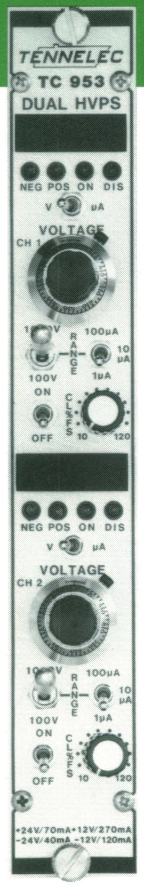
The Tennelec Model TC 452 Quad Single Channel Analyzer offers four independent single channel analyzers in a single-width NIM module.

A front-panel LED mode indicator displays the status of each SCA section. In addition, individual LED indicators give positive visual feedback that each channel is processing pulses.

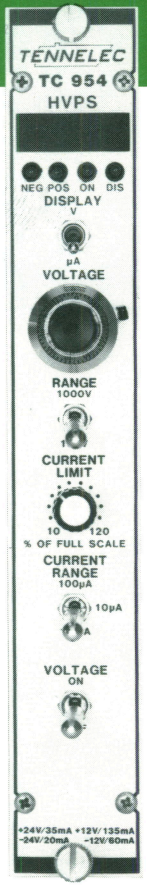
The TC 452 may also be computer controlled as it offers either internal or external lower level reference for each channel.

This unit is ideally designed for multiple counting channels.

PRECISION



TC 953



TC 954

TC 953 Dual High Voltage Power Supply
TC 954 High Voltage Power Supply

The Tennelec TC 953 and TC 954 are two new power supplies which are intended to be used with charged particle detectors or ionization detectors.

These power supplies are well regulated which makes them useful in a number of applications.

Both the TC 953 and the TC 954 display both output current and voltage by way of a built-in four decade digital display. Current measurements down to 1.0 nanoamp can be displayed. In addition, both the TC 953 and TC 954 have a built-in voltage ramp circuit that applies voltage at a rate of 300 volts per second on the 1000 volt range. Output voltages may be computer controlled via a 0 to +10 volt input signal. A disable input is also present. In addition, overload, short-circuit, overvoltage, and overcurrent protection features are provided.

FEATURES

- 0 to ±100 volts or 0 to ±1000 volts at 0 to 100 μA
- Digital display of output current and voltage
- Adjustable current limit
- Output voltages computer controllable
- Disable input
- Built-in voltage ramp

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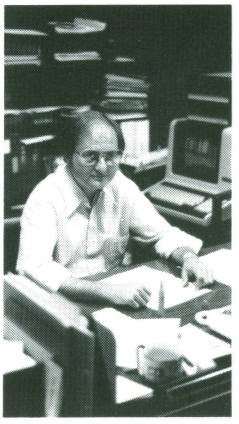
TENNELEC PEOPLE

Patti Kelly, 5 Years
Accounting

Frances Lasher, 14 Years
Detector Fabrication

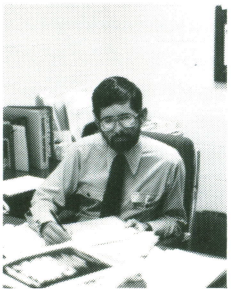
Steve Hinshaw, 12 Years
Engineering



Gene Lawson, 17 Years
Controller

Tom Crawford, 9 Years
Engineering

Phyllis Clark, 13 Years
Purchasing



Wayne Graves, 4 Years
Marketing

Kay Shanlever, 21 Years
Manufacturing Services

Bill Richardson, 1 Year
Charge Particle Detector Test

Bob Stepp, 6 Months
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There is more information and application information; we've only scratched the surface here. We can help you analyze your needs in detail so you can select the best.

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TENNELEC

TC 309
Linear Gate and Stretcher

DESCRIPTION

The **TENNELEC TC 309** Linear Gate and Stretcher combines the basic functions of a linear gate and a pulse stretcher with **superb linearity and temperature stability** in a single-width NIM module. The unit accepts linear input signals, along with the required **coincidence or anticoincidence gating** signals, and generates an output pulse with an amplitude equal to the linear input signal. The output signal shape is optimized for superior performance of a multichannel analyzer in high resolution nuclear spectroscopy systems.

The **TC 309** is totally dc-coupled and features **trailing-edge pulse pileup rejection** to minimize peak shift at high counting rates.

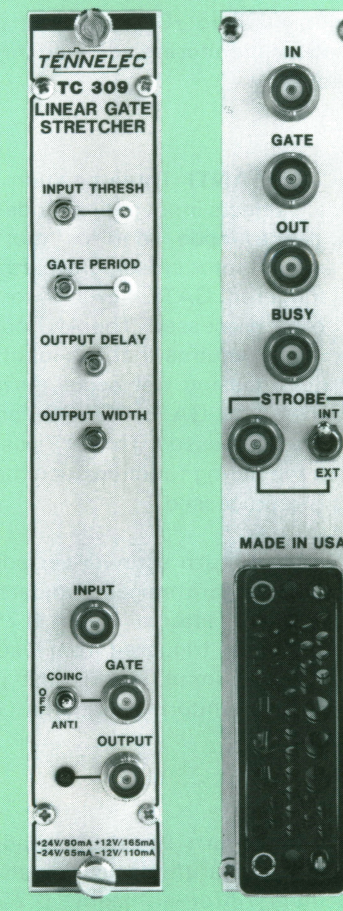
Each linear input pulse must exceed an adjustable threshold discriminator to enable the unit to generate a subsequent output pulse. The 20 mV minimum threshold, along with the 10 volt maximum input range provides a **500:1 dynamic range.** Overloading inputs greater than 10.3 volts are automatically inhibited from generating a subsequent output, thereby reducing dead time. Either coincidence or anticoincidence input gating, with an **adjustable gate period** of 0.25 to 25 μsec, allows events to be selectively processed, thereby reducing the counting rate in subsequent linear analysis equipment and improving the system throughput capability.

The output signal is delayed from the peak of the input signal by an **adjustable delay** of 0.25 to 25 μsec. The **output pulse width is adjustable** from 1 to 10 μsec. The output signal has a fixed rise and fall time of 0.4 μsec and typically exhibits a **droop rate of less than 10 μV/μsec** at room temperature.

A BUSY output indicates the time duration from the peak of the input signal until the end of the output signal. This output can be counted to indicate the number of events processed, or used to indicate when an event has been peak detected and the unit is awaiting an EXTERNAL STROBE input in order to generate an output.

A front-panel **LED OUTPUT indicator** illuminates when an event is output from the unit, thereby providing positive visual indication of the unit's operation.

- **Superb linearity and temperature stability**
- **Coincidence and anti-coincidence gating**
- **Built in pulse pileup rejector**
- **Wide dynamic range**
- **Adjustable gate period, delay, and output pulse width**
- **Typical droop rate of 10 μV/μsec**
- **LED output indicator**
- **Dual unit available - TC 310**



Front Rear

SPECIFICATIONS

PERFORMANCE

GAIN Unity ± 0.5%.

DYNAMIC RANGE 500:1

INTEGRAL NONLINEARITY ≤ ±0.05% for 0.02 to 10 volt inputs with rise time ≥ 200 nsec; typically < ±0.02%.

STRETCHER DROOP RATE ≤ ±50 μV/μsec at 25°C; typically < ±25 μV/μsec over 0 to 50°C range.

GATE FEEDTHROUGH ≤0.04% of signal amplitude with gate closed; typically <0.02%.

GATE PEDESTAL Essentially zero pedestal, factory calibrated.

NOISE ≤ 20 μV rms referred to the input.

TEMPERATURE INSTABILITY
Gain ≤ ±0.003%/°C, 0 to 50°C.
DC Level ≤ ±50 μV/°C, 0 to 50°C.

TC 309 Linear Gate and Stretcher

PILEUP REJECTION Subsequent pulses after peak detection are automatically inhibited until both the output pulse has terminated and the input signal has returned to baseline.

COUNT RATE INSTABILITY Peak position shifts typically less than 0.01% for a Co-60 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time gaussian input signal and incoming rates to 100K cps.

OPERATING TEMPERATURE RANGE 0 to 50°C.

CONTROLS

FRONT PANEL CONTROLS

INPUT THRESH Multi-turn screwdriver adjustable control for setting the threshold level of the input discriminator; variable from +0.02 to +0.4 volts; test point included for monitoring adjusted threshold level.

GATE

COINC-OFF-ANTI Three-position toggle switch selects input gating mode. The COINCidence mode requires that the input discriminator crossing occurs during a triggered GATE PERIOD for the event to be processed. The ANTIcoincidence mode requires that the input discriminator crossing not occur during a triggered inhibit GATE PERIOD for the event to be processed. The OFF position disables the gating function such that all events are processed.

PERIOD Multi-turn screwdriver adjustable control logarithmically adjusts the GATE PERIOD interval from 0.25 to 25 μsec; interval triggered from leading-edge of GATE input signal; test point included for monitoring adjusted GATE PERIOD.

OUTPUT

DELAY Multi-turn screwdriver adjustable control logarithmically adjusts the output-delay-interval from 0.25 to 25 μsec; interval triggered at peak detection; control functions as a variable reset-delay-interval in the external strobe mode.

WIDTH Multi-turn screwdriver adjustable control logarithmically adjust the output-pulse-width from 1 to 10 μsec; triggered following output-delay-interval when operated in the internal strobe mode; externally triggered during reset-delay-interval when operated in the external strobe mode.

REAR PANEL CONTROL

STROBE Two-position toggle switch selects INTernal or EXTernal strobe operation. Internal strobe automatically generates an output following the OUTPUT DELAY interval. External strobe allows external initiation of the output signal during the adjusted reset-delay-interval (OUTPUT DELAY).

INTERNAL CONTROLS

GATE Two-position jumper selects RETRIGgerable (extending) or NON-RETRIGgerable (non-extending) mode for the input gating period. The retriggerable mode extends the gating period from the point of retriggering by the adjusted GATE PERIOD INTERVAL. The non-retriggerable mode ignores gate inputs which occur during a previously triggered GATE PERIOD. The jumper is shipped in the non-triggerable position.

RESPONSE Two-position jumper selects NORMal or FAST response mode for the peak detector. FAST response is desirable for input rise times of less than 0.5 μsec; however, the stretcher droop rate is doubled. The jumper is shipped in the normal response position.

OUTPUT Z_0 Individual two-position jumpers independently select an output impedance of either <1 ohm or 50 ohms for the front- and rear-panel OUTPUT connectors. The outputs are short-circuit protected and the total peak output current is limited to 100 mA. The jumpers are shipped in the 50 ohms position.

CONNECTORS

INPUT Front- and rear-panel BNC type connectors accept positive unipolar or positive lobe leading bipolar signals from 0 to 10 volts with 0.2 to 30 μsec peaking time or rectangular signals with minimum rise time of 0.2 μsec. Input impedance is 1k ohms, dc-coupled.

GATE Front- and rear-panel BNC type connectors accept either positive NIM-standard logic or TTL levels which trigger the adjustable gate period. Interval triggered by a low-to-high transition of the GATE input. Input impedance is 1.5k ohms, dc-coupled.

OUTPUT Front- and rear-panel BNC type connectors provide a positive linear output whose amplitude equals the peak of the input signal. The output pulses are near-rectangular shape with a 0.4 μsec rise/fall time and an adjustable 50% amplitude-width of 1 to 10 μsec. Selectable output impedance of either <1 ohm or 50 ohms. Output has a dc level of 0 ±5 mV and is short-circuited protected.

BUSY Rear-panel BNC type connector provides a positive NIM-standard logic signal (TTL compatible) which is true (high) from peak detection to reset. During external strobe operation, the BUSY output indicates a pulse has been peak detected and the module is awaiting an EXT STROBE to initiate the output pulse. Output impedance is 50 ohms, dc-coupled.

EXT STROBE Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which initiate an output pulse when operating in the external strobe mode. Triggered by a low-to-high transition during the reset-delay-interval (OUTPUT DELAY) or a logic high present at the start of the reset-delay-interval (OUTPUT DELAY). Input impedance is 1.5k ohms, dc-coupled.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 165 mA
−24 V, 65 mA; −12 V, 110 mA

WEIGHT (SHIPPING) 4.0 lbs. (1.8 kg)
(NET) 2.0 lbs. (0.9 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 309 10.0K 886

TENNELEC

TC 310
Dual Linear Gate and Stretcher

DESCRIPTION

The **TENNELEC TC 310** Dual Linear Gate and Stretcher combines the basic functions of a linear gate and a pulse stretcher with **superb linearity and temperature stability** in a single-width NIM module. The unit accepts linear input signals, along with the required **coincidence or anticoincidence gating** signals, and generates an output pulse with an amplitude equal to the linear input signal. The output signal shape is optimized for superior performance of a multichannel analyzer in high resolution nuclear spectroscopy systems.

The **TC 310** is totally dc-coupled and features **trailing-edge pulse pileup rejection** to minimize peak shift at high counting rates.

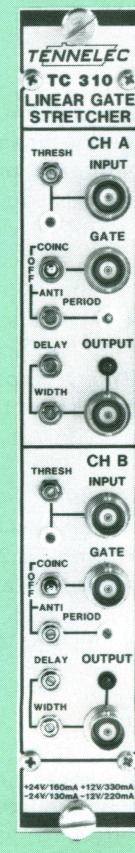
Each linear input pulse must exceed an adjustable threshold discriminator to enable the unit to generate a subsequent output pulse. The 20 mV minimum threshold, along with the 10 volt maximum input range provides a **500:1 dynamic range.** Overloading inputs greater than 10.3 volts are automatically inhibited from generating a subsequent output, thereby reducing dead time. Either coincidence or anticoincidence input gating, with an **adjustable gate period** of 0.25 to 25 μsec, allows events to be selectively processed, thereby reducing the counting rate in subsequent linear analysis equipment and improving the system throughput capability.

The output signal is delayed from the peak of the input signal by an **adjustable delay** of 0.25 to 25 μsec. The **output pulse width is adjustable** from 1 to 10 μsec. The output signal has a fixed rise and fall time of 0.4 μsec and typically exhibits a **droop rate of less than 10 μV/μsec** at room temperature.

A BUSY output indicates the time duration from the peak of the input signal until the end of the output signal. This output can be counted to indicate the number of events processed, or used to indicate when an event has been peak detected and the unit is awaiting an EXTERNAL STROBE input in order to generate an output.

A front-panel **LED OUTPUT indicator** illuminates when an event is output from the unit, thereby providing positive visual indication of the unit's operation.

- **Superb linearity and temperature stability**
- **Coincidence and anti-coincidence gating**
- **Built in pulse pileup rejector**
- **Wide dynamic range**
- **Adjustable gate period, delay, and output pulse width**
- **Typical droop rate of 10 μV/μsec**
- **LED output indicator**
- **Single unit available - TC 309**



Front

Rear

SPECIFICATIONS

The following Performance, Controls and Connectors specifications apply to each linear gate and stretcher channel.

PERFORMANCE

GAIN Unity $\pm$ 0.5%.

DYNAMIC RANGE 500:1

INTEGRAL NONLINEARITY $\leq \pm 0.05\%$ for 0.02 to 10 volt inputs with rise time $\geq$ 200 nsec; typically $< \pm 0.02\%$.

STRETCHER DROOP RATE $\leq \pm 50\,\mu$V/μsec at 25°C; typically $< \pm 25\,\mu$V/μsec over 0 to 50°C range.

GATE FEEDTHROUGH $\leq$0.04% of signal amplitude with gate closed; typically <0.02%.

GATE PEDESTAL Essentially zero pedestal, factory calibrated.

NOISE $\leq 20\,\mu$V rms referred to the input.

TEMPERATURE INSTABILITY
Gain $\leq \pm 0.003\%$/°C, 0 to 50°C.
DC Level $\leq \pm 50\,\mu$V/°C, 0 to 50°C.

TC 310 Dual Linear Gate and Stretcher

PILEUP REJECTION Subsequent pulses after peak detection are automatically inhibited until both the output pulse has terminated and the input signal has returned to baseline.

COUNT RATE INSTABILITY Peak position shifts typically less than 0.01% for a Co-60 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time gaussian input signal and incoming rates to 100K cps.

OPERATING TEMPERATURE RANGE 0 to 50°C.

CONTROLS

FRONT PANEL CONTROLS

INPUT THRESH Multi-turn screwdriver adjustable control for setting the threshold level of the input discriminator; variable from +0.02 to +0.4 volts; test point included for monitoring adjusted threshold level.

GATE

COINC-OFF-ANTI Three-position toggle switch selects input gating mode. The COINCidence mode requires that the input discriminator crossing occurs during a triggered GATE PERIOD for the event to be processed. The ANTIcoincidence mode requires that the input discriminator crossing not occur during a triggered inhibit GATE PERIOD for the event to be processed. The OFF position disables the gating function such that all events are processed.

PERIOD Multi-turn screwdriver adjustable control logarithmically adjusts the GATE PERIOD interval from 0.25 to 25 μsec; interval triggered from leading-edge of GATE input signal; test point included for monitoring adjusted GATE PERIOD.

OUTPUT

DELAY Multi-turn screwdriver adjustable control logarithmically adjusts the output-delay-interval from 0.25 to 25 μsec; interval triggered at peak detection; control functions as a variable reset-delay-interval in the external strobe mode.

WIDTH Multi-turn screwdriver adjustable control logarithmically adjust the output-pulse-width from 1 to 10 μsec; triggered following output-delay-interval when operated in the internal strobe mode; externally triggered during reset-delay-interval when operated in the external strobe mode.

INTERNAL CONTROLS

GATE Two-position jumper selects RETRIGgerable (extending) or NON-RETRIGgerable (non-extending) mode for the input gating period. The retriggerable mode extends the gating period from the point of retriggering by the adjusted GATE PERIOD INTERVAL. The non-retriggerable mode ignores gate inputs which occur during a previously triggered GATE PERIOD. The jumper is shipped in the non-triggerable position.

RESPONSE Two-position jumper selects NORMal or FAST response mode for the peak detector. FAST response is desirable for input rise times of less than 0.5 μsec; however, the stretcher droop rate is doubled. The jumper is shipped in the normal response position.

OUTPUT Z_o Individual two-position jumpers independently select an output impedance of either <1 ohm or 50 ohms for the front- and rear-panel OUTPUT connectors. The outputs are short-circuit protected and the total peak output current is limited to 100 mA. The jumpers are shipped in the 50 ohms position.

STROBE Two-position jumper selects INTernal or EXTernal strobe operation. Internal strobe automatically generates an output following the OUTPUT DELAY interval. External strobe allows external initiaiton of the output signal during the adjusted reset-delay-interval (OUTPUT DELAY).

CONNECTORS

INPUT Front- and rear-panel BNC type connectors accept positive unipolar or positive lobe leading bipolar signals from 0 to 10 volts with 0.2 to 30 μsec peaking time or rectangular signals with minimum rise time of 0.2 μsec. Input impedance is 1k ohms, dc-coupled

GATE Front- and rear-panel BNC type connectors accept either positive NIM-standard logic or TTL levels which trigger the adjustable gate period. Interval triggered by a low-to-high transition of the GATE input. Input impedance is 1.5k ohms, dc-coupled.

OUTPUT Front- and rear-panel BNC type connectors provide a positive linear output whose amplitude equals the peak of the input signal. The output pulses are near-rectangular shape with a 0.4 μsec rise/fall time and an adjustable 50% amplitude-width of 1 to 10 μsec. Selectable output impedance of either <1 ohm or 50 ohms. Output has a dc level of 0 ±5 mV and is short-circuited protected.

BUSY Rear-panel BNC type connector provides a positive NIM-standard logic signal (TTL compatible) which is true (high) from peak detection to reset. During external strobe operation, the BUSY output indicates a pulse has been peak detected and the module is awaiting an EXT STROBE to initiate the output pulse. Output impedance is 50 ohms, dc-coupled.

EXT STROBE Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which initiate an output pulse when operating in the external strobe mode. Triggered by a low-to-high transition during the reset-delay-interval (OUTPUT DELAY) or a logic high present at the start of the reset-delay-interval (OUTPUT DELAY). Input impedance is 1.5k ohms, dc-coupled.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 160 mA; +12 V, 330 mA
−24 V, 130 mA; −12 V, 220 mA

WEIGHT (SHIPPING) 4.5 lbs. (2.0 kg)
(NET) 2.5 lbs. (1.1 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC

TC 452
Quad Single Channel Analyzer

DESCRIPTION

The **TENNELEC** Model **TC 452** Quad Single Channel Analyzer offers the performance specifications and ease of use of four independent single channel analyzers in a single-width NIM module. The **TC 452** has an **exceptionally wide dynamic range** of from 20 mV to 10 volts. A **superior pulse pair resolving time** means a higher count rate capability and could also shorten counting times.

The **TC 452** offers **four independent modes of operation: Integral, Normal, Asymmetrical Window,** and **Symmetrical Window** for each of the four channels. In the INTEGRAL mode all input pulses exceeding the lower level discriminator (LLD) setting generate an SCA Output. The NORMAL mode generates an SCA Output if the input pulse exceeds the LLD but is less than the upper level discriminator (ULD) setting. Both window modes produce an SCA Output if the input signal exceeds the LLD but is less than the ULD. In the ASYMMETRICAL mode, the ULD control sets a window width of from .002V to 0.999V and this window follows the LLD setting. In the **exclusive** SYMMETRICAL mode, the LLD establishes the channel center and the ULD control opens a window of from 0.002V to 0.999V symmetrically around it.

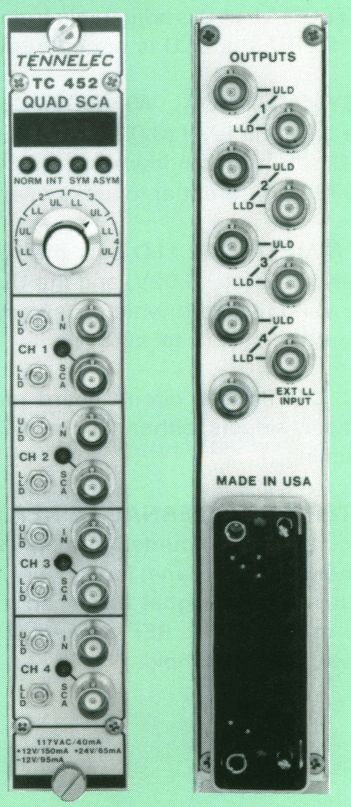
Front-panel **LED channel mode indicators** display the status of each of the four single channel analyzer sections, as selected by an eight-position rotary switch. In addition, **individual LED channel activity indicators** give positive visual feedback that each channel is processing pulses.

The **TC 452** requires only 12, 24, and 117 V power input as supplied by a **standard NIM bin and power supply,** such as the **TENNELEC** model **TB3/TC 911.** An **Autoranging digital voltmeter display** provides 1 mV resolution and autoranges to correctly indicate window widths when in the Asymmetrical or Symmetrical modes.

The **TC 452** may be computer controlled as it offers either **internal or external lower level reference for each channel.** The external LLD input may be positive or negative 0 to 10 volts; the **TC 452** provides automatic polarity switching.

DC or AC input coupling for each channel may be selected by an internal jumper.

- **Exceptionally wide dynamic range**
- **Superior pulse-pair resolving time**
- **Four independent modes of operation:**
  - **Integral**
  - **Normal**
  - **Asymmetrical window**
  - **Symmetrical window**
- **LED channel mode indicators**
- **Individual LED channel activity indicators**
- **Autoranging digital voltmeter display**
- **Requires only standard NIM bin and power supply**
- **Internal or external lower level reference for each channel**
- **DC or AC coupled input**



Front **Rear**

SPECIFICATIONS

The following PERFORMANCE specifications apply to each channel.

PERFORMANCE

DYNAMIC RANGE 500:1.

PULSE PAIR RESOLVING TIME 100 nsec plus output pulse width.

THRESHOLD TEMPERATURE INSTABILITY ≤±0.01%/°C of full scale, 0 to 50°C.

WINDOW WIDTH VARIATION ≤0.1% of full scale window width over the linear 0 to +10V range.

DISCRIMINATOR NONLINEARITY ≤0.1% of full scale for both discriminators.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 452 Quad Single Channel Analyzer

CONTROLS

DVM SWITCH 8-position rotary switch selects the LLD or ULD discriminator threshold for the DVM display.

ULD Front-panel screwdriver adjustable potentiometer to set the upper level discriminator from .02V to 9.99V or window width from 0.002V to 0.999V.

LLD Front-panel screwdriver adjustable potentiometer to set the lower level discriminator from 0.02V to 9.99V.

NORM/INT/SYM/ASYM Internal printed circuit board mounted four-position slide switch selects the operating mode for each channel. Accessible through the module's side shield; mode for each channel is indicated by front-panel LED.

NORMAL LLD and ULD are independently adjustable (0.02V to +9.99V); differential mode is operative.

INTEGRAL LLD is adjustable from 0.02V to +9.99V; the ULD is not operative.

ASYMMETRICAL WINDOW LLD sets the baseline level (0.02V to +9.99V) and ULD sets the window width (0.002V to 0.999V); differential mode is operative.

SYMMETRICAL LLD sets the baseline level (0.02V to +9.99V) and the ULD sets the window width which is symmetrical about the LLD (0 to ±0.5V).

AC/DC Printed circuit board mounted jumper selects either DC or AC input coupling.

INTERNAL/EXTERNAL LL REF Printed circuit board mounted jumper selects either the front-panel lower level control or the voltage signal furnished through the rear-panel LL REF connector as the lower level threshold.

INDICATORS

DIGITAL VOLTMETER Indicates setting of selected threshold. Autoranging in window modes from 0.002V-0.999V. Normal range 0.02V-9.99V.

NORM/INT/SYM/ASYM LED indicators display the selected operation mode for each channel as selected by the front-panel rotary switch.

ACTIVITY LED LED indicators, one per channel, light to show that an SCA output pulse has been generated.

INPUTS

IN Front-panel BNC connectors, one per channel, accept unipolar or bipolar signal, 0 to +9.99V linear range; ≥100 nsec width, Z_{in} ≥900 ohms. Input protected to ±24V.

EXT LL INPUT Rear-panel BNC connector accepts positive or negative 0-9.99V; input displayed on DVM. 0 to ±9.99 volts on this connector corresponds to a 0 to 9.99 volt lower level discriminator setting. Z_{in} ≥10k ohms.

OUTPUTS

SCA Front-panel BNC connectors, one per channel, provide positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs when operating mode conditions are met and the trailing edge of the linear input crosses the lower level threshold.

ULD Rear-panel BNC connectors, one per channel, provide positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs when the leading edge of the linear input crosses the upper level or window threshold.

LLD Rear-panel BNC connector, one per channel, provides positive NIM standard output, nominally +5V, 500 nsec wide; Z_o = 50 ohms. Output occurs as the leading edge of the linear input crosses the lower level threshold.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 65 mA; +12 V, 150 mA
−24 V, 0 mA; −12 V, 95 mA
117 V AC, 40 mA

WEIGHT (SHIPPING) 5.1 lbs. (2.3 kg)
(NET) 2.8 lbs. (1.3 kg)

DIMENSIONS NIM-standard single width module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 452 10.0K 386

TENNELEC

TC 948
High Voltage Supply

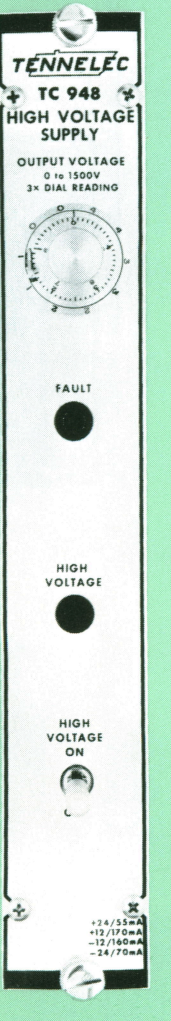
DESCRIPTION

The TENNELEC TC 948 High Voltage Supply is a **single-width NIM module** designed for photomultiplier and electron multiplier tubes. The output is continuously adjustable from **0 to +1500V** with a current capability of **1 mA**. The supply incorporates a precision dial to permit a high accuracy and repeatability of the output voltage level.

Automatic fault protection against overloads, arcing, and short circuits is provided. A front-panel lamp indicates if the protection circuits have been activated.

The unit obtains its power completely from the NIM bin power supply.

- **0 to +1500 V dc at 1 mA**
- **Automatic Fault Protection**
- **Single width NIM Module**



SPECIFICATIONS

PERFORMANCE

OUTPUT VOLTAGE 0 to +1500 volts

OUTPUT CURRENT 0 to 1 mA

RIPPLE AND NOISE ⩽ 10 mV peak-to-peak (typically ⩽ 3 mV).

REGULATION < 0.001%

TEMPERATURE INSTABILITY <±0.01%/°C, 0 to 50°C

LONG-TERM DRIFT <0.01%/hr with constant line and load.

REPEATABILITY 0.05%

CONTROLS

HIGH VOLTAGE ON/OFF Two position locking toggle switch to activate supply.

OUTPUT VOLTAGE Precision 10-turn dial calibrated from 0 to 1.5 kV.

HIGH VOLTAGE INDICATOR Front-panel lamp indicates when high voltage is on.

FAULT INDICATOR Front-panel lamp indicates if the high voltage fault protection circuit has been activated.

OUTPUTS

HV OUT Rear-panel SHV Type Connector furnishes the output voltage.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 55 mA; +12 V, 170 mA
−24 V, 70 mA; −12 V, 165 mA

WEIGHT
(SHIPPING) 5 lbs. 2 oz.(2.3 kg)
(NET) 2 lbs. 2 oz.(0.96 kg)

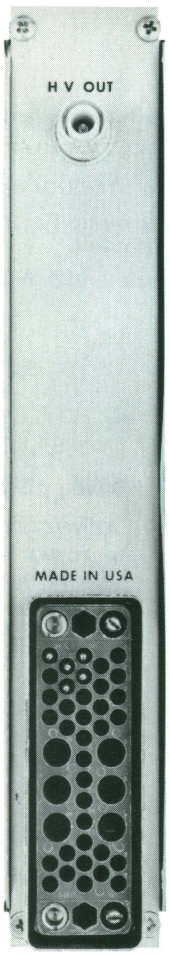
DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provide with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 948 High Voltage Supply



TENNELEC INC.

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

PHONE 615-483-8405 TWX 810-572-1018

TC 948 10.0K 985

TENNELEC

TC 950
Detector Bias Supply

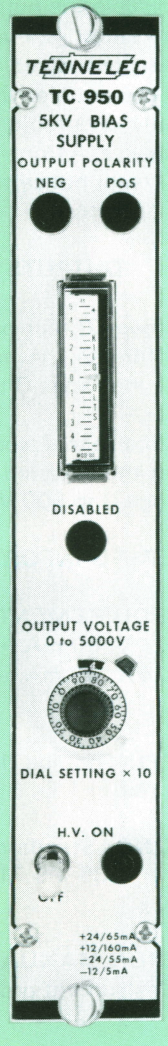
DESCRIPTION

The TENNELEC TC 950 Detector Bias Supply is a single width NIM module which provides a bias voltage of either **positive or negative polarity** for semiconductor detectors or for any type of detector requiring bias currents less than 100 μA; this includes proportional counters and ionization chambers.

Two simultaneous outputs are provided, one for a range of **0 to 5 kV** and the other from **0 to 500 V.** Both output voltages are continuously adjustable by way of a front-panel **5-turn direct-reading potentiometer.** Either polarity is available through both ranges, with the polarity selected by an internal switch and indicated by front-panel lights. A **front-panel meter** monitors the output voltage and provides a visual indication of the polarity and magnitude of the output voltage. A rear-panel disable input is provided for remote shutdown of the output voltage.

The TC 950 Detector Bias Supply receives its necessary operating power through the rear-panel module connector from the TENNELEC TB-3/TC 911 **NIM Bin and Power Supply,** or any other Type I, Class A powered Bin in which it is installed for operation.

- **0- to 5-kV and 0- to 500-V simultaneous outputs**
- **Positive or negative output polarity**
- **5-turn direct-reading voltage control**
- **Front-panel meter**
- **Receives power from NIM Bin Supply**



SPECIFICATIONS

PERFORMANCE

BIAS VOLTAGE OUTPUTS Two output ranges, 0 to 5 kV and 0 to 500 V. Both ranges are available simultaneously.

BIAS POLARITY Either positive or negative for both output ranges, selectable by an internal switch and indicated on the front panel.

BIAS CONTROL 5-turn direct-reading precision potentiometer.

OUTPUT CURRENT 0 to 100 μA.

VOLTAGE STABILITY $\leqslant$0.1%/hr output voltage variation assuming temperature, load and line voltage are constant.

NOISE AND RIPPLE $\leqslant$ 10 mV peak to peak from 5 Hz to 50 MHz.

TEMPERATURE STABILITY $\leqslant$0.02%/°C through 0 to 50°C operating range.

OVERLOAD PROTECTION Short-circuit and overload protection is internally provided with automatic output restoration.

RESETABILITY Output voltage resettable to within 0.2%.

DIAL ACCURACY $\pm$ 1% of full scale.

CONTROLS AND DISPLAYS

OUTPUT VOLTAGE 5-turn direct-reading potentiometer adjusts output levels simultaneously for both output ranges. A front-panel meter indicates the polarity and magnitude of the output voltage.

POLARITY +/− The polarity is selected by an internal switch for both output ranges with two front-panel lamps indicating the polarity selected.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 950 Detector Bias Supply

HIGH VOLTAGE ON/OFF Toggle switch and indicator lamp show when the instrument circuits are turned on to provide an output.

INPUTS

POWER All input power is furnished through the rear-panel module connector from the NIM Bin Power Supply.

DISABLE A rear-panel BNC connector is provided to disable the high voltage output. An internal jumper allows selection of the disable mode. LOW will disable the output of the TC 950 for a pull to ground from either +5 volts or an open circuit. HIGH will disable the output for a pull to ground from either −24 volts or an open circuit. These two disable modes make the TC 950 compatible with virtually any commercially available high voltage shutdown device. A front-panel indicator light gives visual notice that the disable function is operative.

OUTPUTS

0-5000 V Two (2) rear-panel type SHV connectors furnish the adjusted output voltage over the range 0 to 5000 V.

0-500 V A rear-panel type SHV connector furnishes the adjusted output voltage over the range 0 to 500 V.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 80 mA; +12 V, 210 mA
−24 V, 40 mA; −12 V, 3 mA

WEIGHT
(SHIPPING) 3 lbs. 13 oz. (1.73 kg)
(NET) 1 lb. 6 oz. (0.63 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

TC 950 10.0K 985

TENNELEC

TC 813
Pulser

DESCRIPTION

The **TENNELEC TC 813** Pulser is a single-width NIM module designed to **simulate the output signal from a solid-state or scintillation detector/pre-amplifier combination,** thereby providing a means of testing and calibrating the electronics in a nuclear counting system.

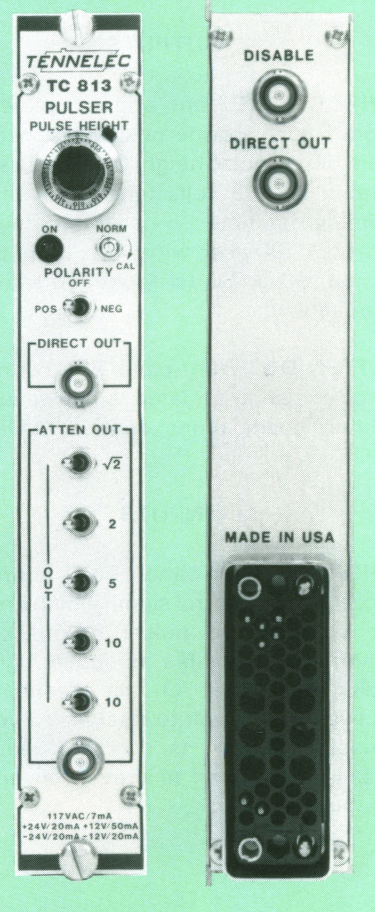
Calibration of nuclear spectroscopy systems and multichannel analyzers, evaluation of system stability, measuring the integral nonlinearity and noise of amplifiers, and selecting delays in coincidence timing systems are **typical applications** for the **TENNELEC TC 813** Pulser.

The TC 813 can be calibrated to read directly in terms of equivalent energy. The continuous pulse height control has a maximum nonlinearity of ±0.25% and the step attenuators are comprised of 1% resistors. A very stable power supply and mercury relay simulate the nuclear pulses, producing pulses with exponential rise times of ≤5 nsec and fall time constants of 130 to 400 μsec. The internal reference voltage is **essentially independent of any modular power supply or ac line voltage changes.**

Five toggle switches place **attenuation of over 1,000:1** in the attenuated output. **Gold-plated switch contacts** ensure reliable electrical contact and eliminates the intermittant continuity problems found in other pulsers. The **direct output precedes the attenuator switches** and provides a means of stable oscilloscope triggering.

The **TC 813** has a **Disable input** that is synchronized with the relay to prevent erroneous outputs. This input may be used to gate the **TC 813** Pulser either on or off by remote or computer control.

- **Simulates detector output signals**
- **Wide range of typical applications**
- **Can be calibrated to read directly in units of energy**
- **Output essentially independent of supply voltage changes**
- **Direct and attenuated outputs**
- **Gold-plated switch contacts**
- **Disable input for gated operation**



Front Rear

SPECIFICATIONS

PERFORMANCE

TEMPERATURE INSTABILITY ≤ ±0.005%/°C, 0 to 50°C.

SUPPLY VOLTAGE INSTABILITY ≤ ±0.001% for a 1% change of the ±24 volt supply voltages.

RIPPLE AND NOISE ≤0.003% of pulse amplitude.

INTEGRAL NONLINEARITY ≤ ±0.25% of full-scale.

RISE TIME (10%-to-90%) ≤5 nsec exponential.

FALL TIME (90%-to-10%) Exponential decay with 130, 200 or 400 μsec time constant, depending on output terminations.

PULSE REPETITION RATE 50 or 60 Hz depending on AC line frequency.

OPERATING TEMPERATURE 0 to 50°C.

CONTROLS AND INDICATORS

PULSE HEIGHT Front-panel 10-turn potentiometer and dial controls output pulse height from 0 to 10 volts open circuit (0 to 5 volts terminated into 50 ohms).

ON Front-panel indicator illuminates when the POLARITY switch is in either the POS or NEG position and the pulser is not disabled through the rear-panel DISABLE input.

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INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 813 Pulser

NORM Front-panel multi-turn potentiometer allows a 2:1 variation of the output amplitude for normalization of the PULSE HEIGHT dial, enabling the user to calibrate the PULSE HEIGHT dial directly in units of energy. Setting the NORM control fully clockwise provides a calibrated 0 to 10 volt output range.

POLARITY Front-panel three-position toggle switch selects positive or negative output polarity. The center OFF position disables the pulser output.

ATTEN Five front-panel two-position toggle switches select attenuation factors of $\sqrt{2}$, 2, 5, 10 and 10.

DISABLE PCB-mounted jumper selects high (>2 volts) or low (<1 volt) mode for rear-panel DISABLE input.

OUTPUTS

DIRECT OUT Front- and rear-panel BNC connectors provide positive or negative tail pulses; pulse height 0 to 10 volts open circuit (0 to 5 volts terminated into 50 ohms); rise time ≤5 nsec; fall time constant of 400 μsec with one output terminated; 50 or 60 Hz repetition rate (line frequency).

ATTEN OUT Front-panel BNC connector provides an attenuated tail pulse output. Other specifications identical to DIRECT OUT.

INPUTS

DISABLE Rear-panel BNC connector accepts a dc control signal which enables or disables the pulser output signal. Internally selectable as active high (>2 volts to disable; <1 volt to enable) or active low (<1 volt to disable; >2 volts to enable). Disable is synchronized with relay drive signal to prevent erroneous outputs.

ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 20 mA; +12 V, 50 mA
−24 V, 20 mA; −12 V, 20 mA
117 VAC, 7 mA

WEIGHT (SHIPPING) 5 lbs. (2.2 kg)
(NET) 3 lbs. (1.3 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORIES One NC-TERM-50, 50 ohm BNC terminator provided with each **TC 813**.

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018
TC 813 10.0K 286

TENNELEC

TC 953
Dual High Voltage Power Supply

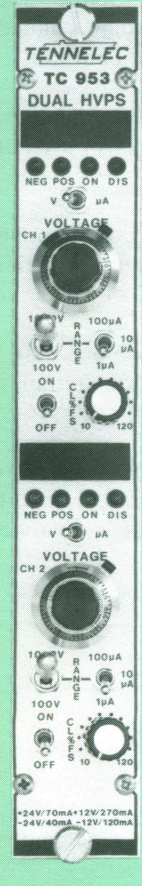
DESCRIPTION

The **TENNELEC TC 953** Dual High Voltage Power supply offers **two, completely independent, 0 to ± 100 volts or 0 to ± 1000 volts at 0 to 100 μA** power supplies with **separate digital multimeter (DMM) displays for either voltage or current.** It is a highly reliable, well-regulated power supply that is ideally suited for use with silicon surface barrier detectors, ion-implanted silicon detectors, lithium-drifted silicon, Si(Li), detectors, cadmium telluride (CdTe) or proportional detectors.

Current measuring capabilities down to 1 nanaoampere are incorporated in the **TC 953**. This is especially useful in alpha spectroscopy work as it allows for easy compensation of the voltage drop in the bias resistor network due to detector leakage currents. No interpolation is necessary because the DMM reads leakage current directly in full scale ranges of 1, 10, or 100 μA. An exclusive, **current limit** feature protects expensive systems from excessive currents and is **adjustable** from 10 to 120% of full scale.

The **TC 953** has a **built-in voltage ramp circuit** that applies voltage at a rate of approximately 300 volts/second on the 1000V range and 30 volts/second on the 100V range. **Output voltages** may be **computer controllable**; a 0 to + 10 volt signal on a rear-panel BNC connector corresponds to a 0 to full scale voltage output. A **disable input** is available to reduce the voltage to zero as in a vacuum interlock application where the bias voltage should be disabled when the spectrometer is vented to atmosphere. In addition, **overload, short-circuit, overvoltage, and overcurrent protection** features are built-in the **TC 953.**

- **Two completely independent channels; 0 to ± 100 volts or 0 to ± 1000 volts at 0 to 100 μA outputs**
- **Separate DMM displays for output voltage or current**
- **Adjustable current limit**
- **Built-in voltage ramp circuit**
- **Output voltages computer-controllable**
- **Disable input**
- **Overload, short-circuit, overvoltage, and overcurrent protected**



SPECIFICATIONS

The following PERFORMANCE, CONTROLS, and CONNECTORS specifications apply to each high voltage channel.

PERFORMANCE

OUTPUT VOLTAGE 0 to ± 100V or 0 to ± 1000V dc.

OUTPUT CURRENT 0 to 100 μA.

OUTPUT POLARITY Positive or negative, selectable through left side panel and independent for each channel.

REGULATION ≤0.001% or 1 mV (whichever is greater) variations in output voltage for load changes within operating range.

INSTABILITY Long-term drift of output voltage less than 0.001%/24 hr. period at constant temperature and load.

RIPPLE ≤1 mV peak to peak 5 Hz to 50 MHz (typically <300 μV at full load).

TEMPERATURE INSTABILITY ≤± 30 ppm/°C, 0 to 50°C (typically <±10 ppm).

CALIBRATION INACCURACY Output voltage will differ from front panel settings by less than 0.25%.

RESOLUTION 0.5V or better on 1000 volt range; 0.05V on 100 volt range.

RESETTABILITY Resettable to within 1 volt (1000V range); 0.1 volt (100V range).

TC 953 Dual High Voltage Power Supply

OVERLOAD PROTECTION Overload, short-circuit, over-voltage and adjustable current limit with automatic output restoration.

DISPLAY INACCURACY $\leq \pm .05\% \pm 1$ Least Significant Digit (LSD) for current and voltage.

CONTROLS AND INDICATORS

NEG Red front-panel LED illuminates to indicate that negative high voltage is selected for this channel.

POS Red front-panel LED illuminates to indicate that positive high voltage is selected for this channel.

ON Red front-panel LED illuminates to show that the high voltage section is active for this channel.

DIS Red front-panel LED illuminates to indicate the high voltage section is disabled for this channel.

DISPLAY Two-position toggle switch selects V (volts) or μA (current) for display on DMM.

VOLTAGE Continuously variable 10-turn potentiometer varies output voltage from 0-1000 or 0-100 volts full scale.

RANGE Two-position locking toggle switch selects either 1000 volts or 100 volts full scale.

CURRENT RANGE Three-position toggle switch selects 1 μA, 10 μA, or 100 μA full scale current range for display on DMM.

CURRENT LIMIT Continuously variable single-turn potentiometer sets output current limit from 10-120 percent of selected full scale.

VOLTAGE Two-position toggle switch enables or disables the high voltage output.

CONNECTORS

INPUTS

DISABLE Rear-panel BNC type connector accepts a short to ground, or a NIM positive logic zero, to disable the power supply.

REMOTE Rear-panel BNC type connector accepts 0 to + 10 volts input voltage to control the output voltage from 0-1000 volts or 0-100 volts, depending upon range selection. Z_{in} = 10k ohms.

OUTPUT

OUTPUT Rear-panel SHV type connector supplies 0 to $\pm$1000 volts, or 0 to $\pm$100 volts, depending upon range selection.

ORDERING INFORMATION

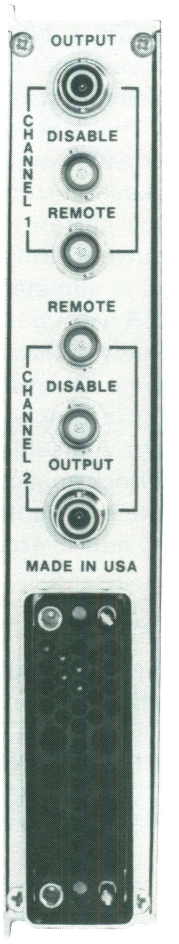
POWER REQUIREMENTS
(Both channels at 1000V, 100 μA)
+24 V, 70 mA; +12 V, 270 mA
−24 V, 40 mA; −12 V, 120 mA

Note: At high load currents this module exceeds NIM specification current limits for +12V. Depending upon your NIM power supply, you may not be able to power a fully-loaded bin of these units.

WEIGHT (SHIPPING) 5.0 lbs. (2.28 kg)
(NET) 3.0 lbs. (1.37 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.



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TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

TC 953 10.0K 1086

TENNELEC

TC 954
High Voltage Power Supply

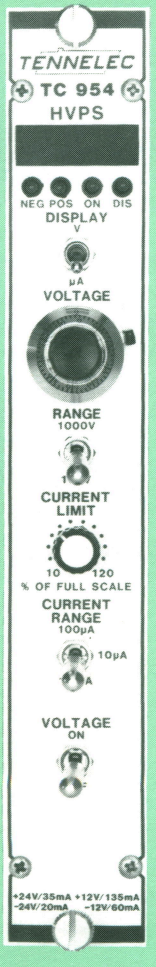
DESCRIPTION

The **TENNELEC TC 954** High Voltage Power supply offers **0 to ± 100 volts or 0 to ± 1000 volts at 0 to 100 μA** with **a digital multimeter (DMM) display for either voltage or current.** It is a highly reliable, well-regulated power supply that is ideally suited for use with silicon surface barrier detectors, ion-implanted silicon detectors, lithium-drifted silicon, Si(Li), detectors, cadmium telluride (CdTe) or proportional detectors.

Current measuring capabilities down to 1 nanoampere are incorporated in the **TC 954**. This is especially useful in alpha spectroscopy work as it allows for easy compensation of the voltage drop in the bias resistor network due to detector leakage currents. No interpolation is necessary because the DMM reads leakage current directly in full scale ranges of 1, 10, or 100 μA. An exclusive, **current limit** feature protects expensive systems from excessive currents and is **adjustable** from 10 to 120% of full scale.

The **TC 954** has **a built-in voltage ramp circuit** that applies voltage at a rate of approximately 300 volts/second on the 1000V range and 30 volts/second on the 100V range. **Output voltages** may be **computer controllable**; a 0 to + 10 volt signal on a rear-panel BNC connector corresponds to a 0 to full scale voltage output. A **disable input** is available to reduce the voltage to zero as in a vacuum interlock application where the bias voltage should be disabled when the spectrometer is vented to atmosphere. In addition, **overload, short-circuit, overvoltage, and overcurrent protection** features are built-in the **TC 954.**

- **Provides 0 to ± 100 volts or 0 to ± 1000 volts at 0 to 100 μA**
- **DMM display for output voltage or current**
- **Adjustable current limit**
- **Built-in voltage ramp circuit**
- **Output voltages computer-controllable**
- **Disable input**
- **Overload, short-circuit, overvoltage, and overcurrent protected**



SPECIFICATIONS

PERFORMANCE

OUTPUT VOLTAGE 0 to ± 100V or 0 to ± 1000V dc.

OUTPUT CURRENT 0 to 100 μA.

OUTPUT POLARITY Positive or negative, selectable through left side panel.

REGULATION ≤0.001% or 1 mV (whichever is greater) variations in output voltage for load changes within operating range.

INSTABILITY Long-term drift of output voltage less than 0.001%/24 hr. period at constant temperature and load.

RIPPLE ≤1 mV peak to peak 5 Hz to 50 MHz (typically <300 μV at full load).

TEMPERATURE INSTABILITY ≤± 30 ppm/°C, 0 to 50°C (typically <±10 ppm).

CALIBRATION INACCURACY Output voltage will differ from front panel settings by less than 0.25%.

RESOLUTION 0.5V or better on 1000 volt range; 0.05V on 100 volt range.

RESETTABILITY Resettable to within 1 volt (1000V range); 0.1 volt (100V range).

OVERLOAD PROTECTION Overload, short-circuit, over-voltage and adjustable current limit with automatic output restoration.

DISPLAY INACCURACY ≤±.05% ± 1 Least Significant Digit (LSD) for current and voltage.

TC 954 High Voltage Power Supply

CONTROLS AND INDICATORS

NEG Red front-panel LED illuminates to indicate that negative high voltage is selected for this channel.

POS Red front-panel LED illuminates to indicate that positive high voltage is selected for this channel.

ON Red front-panel LED illuminates to show that the high voltage section is active for this channel.

DIS Red front-panel LED illuminates to indicate the high voltage section is disabled for this channel.

DISPLAY Two-position toggle switch selects V (volts) or μA (current) for display on DVM.

VOLTAGE Continuously variable 10-turn potentiometer varies output voltage from 0-1000 or 0-100 volts full scale.

RANGE Two-position locking toggle switch selects either 1000 volts or 100 volts full scale.

CURRENT RANGE Three-position locking toggle switch selects 1 μA, 10 μA, or 100 μA full scale current range for display on DMM.

CURRENT LIMIT Continuously variable single-turn potentiometer sets output current limit from 10-120 percent of selected full scale.

VOLTAGE Two-position locking toggle switch enables or disables the high voltage output.

CONNECTORS

INPUTS

DISABLE Rear-panel BNC type connector accepts a short to ground, or a NIM positive logic zero, to disable the power supply.

REMOTE Rear-panel BNC type connector accepts 0 to + 10 volts input voltage to control the output voltage from 0-1000 volts or 0-100 volts, depending upon range selection. Z_{in} = 10k ohms.

OUTPUT

OUTPUT Rear-panel SHV type connector supplies 0 to ±1000 volts, or 0 to ±100 volts, depending upon range selection.

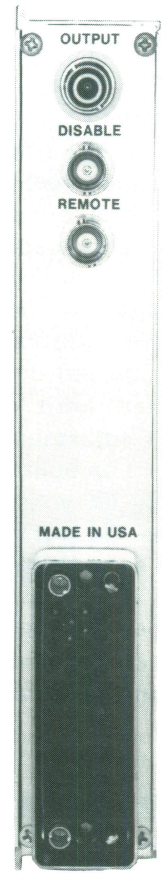
ORDERING INFORMATION

POWER REQUIREMENTS
+24 V, 35 mA; +12 V, 135 mA
−24 V, 20 mA; −12 V, 60 mA

WEIGHT (SHIPPING) 4.5 lbs. (2.05 kg)
(NET) 2.5 lbs. (1.14 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.



TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
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TC 954 10.0K 1086

TENNELEC

TC 248
Fast/Slow Amplifier

DESCRIPTION

The **TENNELEC** Model **TC 248** is both a high performance **spectroscopy amplifier** and a **timing filter amplifier** in a single-width NIM module. It is ideally suited for **large silicon surface barrier detector arrays** and other applications where both spectroscopy and timing/coincidence information are required. The low noise spectroscopy amplifier section may be used alone for semiconductor detectors, proportional detectors, and scintillation detectors at high and low count rates.

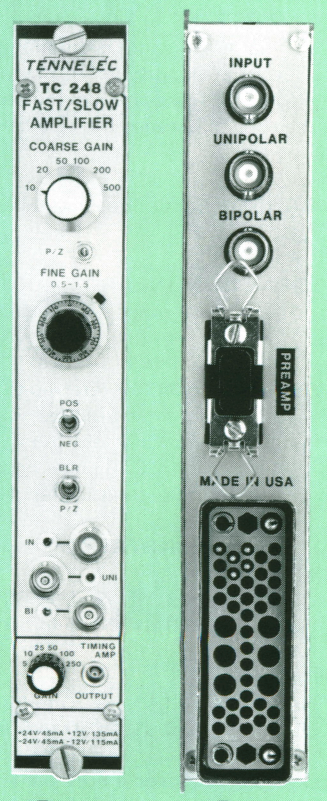
The timing filter amplifier has **separate integration/differentiation time constants, coarse gain** switch, and a **rise time** of less than **10 nanoseconds.** The linear output amplitude range is from 0 to −5 volts into 50 ohms.

The spectroscopy amplifier incorporates four active integration networks which generate very symmetrical near-gaussian **unipolar** signals. **Bipolar** signals are also available as a separate output. **Switch selectable peaking times** of 1, 3, and 6 μsec (0.5, 1.5, and 3.0 μsec shaping times) allow the **TC 248** to match the signal processing requirements of most detectors. The symmetry of the pulse-shaping network optimizes the signal-to-noise ratio while allowing excellent count rate capability. A **gated baseline restorer** (BLR) with **automatic threshold** and restorer rate circuits provides **superb high count rate performance** without degrading ultimate resolution. The **excellent dc stability** of the **TC 248** eliminates spectrum broadening often caused by dc shift of the amplifier output thus insuring superior performance.

TENNELEC preamplifier power cables have an **integral, high-quality coaxial signal cable** that **eliminates** the need for a separate BNC cable between the preamplifier and amplifier. The **TC 248** has selectable output impedance of either <1 ohm or 50 ohms.

An optional delay allows the unipolar output from the spectroscopy amplifier to be delayed by 2 μsec for gating applications.

- **Timing Filter Amplifier and Spectroscopy Amplifier in a single-width NIM module**
- **Timing Filter Amplifier:**
  - **Separate integration/differentiation time constants**
  - **Coarse gain switch, X5-X250**
  - **Rise time <10 nsec**
- **Spectroscopy Amplifier:**
  - **Gated baseline restorer with automatic threshold control**
  - **High count rate capability**
  - **Multiple shaping time constants**
  - **Unipolar and Bipolar Outputs**
  - **"One cable preamplifier connection"**



Front **Rear**

SPECIFICATIONS

TIMING FILTER AMPLIFIER PERFORMANCE

INPUT AMPLITUDE RANGE 0 to ±1 volt linear signal; 0 to ±3.5 volts dc; maximum input (signal plus dc) ±4.5 volts.

OUTPUT AMPLITUDE RANGE 0 to −5 volts linear into a 50 ohm load.

RISETIME Typically ≤ 10 nsec with minimum integration and maximum differentiation.

GAIN TEMPERATURE INSTABILITY <±0.1%/°C, 0 to 50°C

CONTROLS

FRONT-PANEL CONTROL

GAIN Six-position rotary switch selects gain factors from 5 to 250 in a 1-2.5-5 sequence.

INTERNAL CONTROLS
(Accessible through the module's side shield)

INPUT POLARITY Two-position slide switch selects either positive or negative polarity preamplifier signals for the timing amplifier input.

DIFFERENTIATOR TIME CONSTANT Four individual two-position slide switches select differentiator time constants of 10, 20, 50, and 100 nsec. Switches may be used in combination to provide intermediate time constants, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. All switches OUT provides a 5 nsec time constant.

INTEGRATOR TIME CONSTANT Four individual two-position slide switches select integrator time constants of 10, 20, 50, and 100 nsec. Switches may be used in combination to provide intermediate time constants, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. The rise time is approximately 2.2 times the selected time constant.

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TC 248 FAST/SLOW AMPLIFIER

INPUT

COMMON INPUT Front- and rear-panel BNC type connectors accept either positive or negative pulses with rise times less than the selected peaking time and decay times of 35 μsec to infinity. The input impedance is 50 ohms dc-coupled, and the input is protected to ±4.5 volts absolute maximum.

NOTE: The **INPUT** is common to both the Timing Filter and Spectroscopy Amplifiers.

OUTPUT

OUTPUT Lemo type connector provides shaped timing output pulses with a full-scale linear range of 0 to −5 volts (−7 volts maximum) when terminated into a 50 ohm load. Rise time and decay time selected by the **DIFFERENTIATOR** and **INTEGRATOR** switch settings.

SPECTROSCOPY AMPLIFIER

PERFORMANCE

PULSE SHAPING Active shaping networks produce near-gaussian shaped unipolar pulses with selectable peaking times (T_p) of 1, 3, or 6 μsec (0.5, 1.5, or 3.0 μsec shaping time). The unipolar pulse width is equal to 2.8 times the selected peaking time. The bipolar pulse zero crossover is delayed from the prompt unipolar peak by 0.32 times the selected peaking time.

GAIN RANGE Continuously variable from X5 to X750.

INTEGRAL NONLINEARITY ≤±0.05% over 0 to +10V output range for 3 μsec peaking time.

NOISE Less than 3.0 μV referred to the input for 6 μsec peaking time, unipolar shaping and maximum gain; typically less than 3.2 μV for gain greater than 100. Bipolar typically less than 5.0 μV for gain greater than 100.

TEMPERATURE INSTABILITY

UNIPOLAR
- Gain ≤±0.01%/°C, 0 to 50°C
- DC Level ≤±10 μV/°C, 0 to 50°C

BIPOLAR
- Gain ≤±0.01%/°C, 0 to 50°C
- DC Level ≤±30 μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 3 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X300 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X300 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar)* Typically less than 10% FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100k cps.

SPECTRUM SHIFT (Unipolar)* Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 μsec peaking time and incoming rate of 1 to 100k cps.

*Results may not be reproducible if measurements are made with a detector which exhibits an extremely large number of slow-rise time signal components.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

FRONT-PANEL CONTROLS

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500. The dial numbers should be considered as multipliers operating on the COARSE GAIN setting, with 500 and 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN controls extends the total gain range from 5 to 750.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of preamplifier decay times from 35 μsec to infinity.

POS-NEG Two-position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

BLR-P/Z Two-position toggle switch enables the baseline restorer in the BLR position. The P/Z position disables the baseline restorer for accurate pole-zero cancellation adjustment.

INTERNAL CONTROLS
(Accessible through the module's side shield)

PEAKING TIME Four individual three-position slide switches select unipolar peaking times of 1, 3, or 6 μsec. Bipolar peaking time equals 0.78 of selected unipolar peaking time.

OUTPUT IMPEDANCE Individual two-position slide switches selects an output impedance of either <1 ohm or 50 ohms for the UNIPOLAR and BIPOLAR outputs. All outputs are short circuit protected in either position.

INPUT

COMMON INPUT Front- and rear-panel BNC type connectors accept either positive or negative pulses with rise times less than the selected peaking time and decay times of 35 μsec to infinity. Z_{in} = 50 ohms, dc-coupled. Input protected to ±4.5 volts maximum.

OUTPUTS

UNIPOLAR Front- and rear-panel BNC type connectors. Full-scale range of 0 to +10V (+11.5V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored and short-circuit protected.

BIPOLAR Front- and rear-panel BNC type connectors. Full-scale range of 0 to +10V (+11.5V max.). Switch selectable output impedance of either <1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are short-circuit protected.

PREAMP Rear-panel 9-pin Amphenol 17-10090 connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

TENNELEC preamplifier power cables contain an internal coaxial cable which establishes a signal connection between the preamplifier output and amplifier input, thus eliminating the need for a separate external BNC signal cable.

ORDERING INFORMATION

POWER REQUIREMENTS *(excluding preamp)*

+24 V, 45 mA; +12 V, 135 mA
−24 V, 45 mA; −12 V, 115 mA

WEIGHT (SHIPPING) 5.0 lbs. (2.3 kg)
(NET) 2.5 lbs. (1.2 kg)

DIMENSIONS Standard single-width NIM module (1.35 x 8.714 in.) per TID-20893 (Rev.).

INSTRUCTION MANUAL One provided with each instrument ordered.

OPTION The TC 248 may be ordered with a TC 248-02 option which delays the unipolar output by 2 μsec with respect to the input. A two-position internal slide switch selects either prompt (Out) or the 2 μsec delay (In) for the unipolar output.

TENNELEC INC.

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.

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TC 248 10.0K 286

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TELEPHONE 615-483-8405 / TWX 810-572-1018

Product Specifications Sheet

Tennelec Geiger Mueller and Proportional Counter Detectors

	TD2902 0.6" dia. GM Tube and Stand	TD2903 1.4" dia GM Tube and Stand
Operating Voltage	+500 volts	+900 volts
Fill Gas	Neon & Halogen	Neon & Halogen
Window	Mica	Mica
Window Thickness	1.5-2.0 mg/cm^2	1.4-2.0 mg/cm^2
Window Diameter	0.360" (9.1mm)	1.16" (29.4mm)
Plateau Length	450-600 volts	800-950 volts
Plateau slope	10%/100 volts	10%/100 volts

	TD2904 0.5" dia Proportional Counter w/SHV connector	TD2905 1.0" dia Proportional Counter w/SHV connector
Operating Voltage	+1500 volts	+1450 volts
Fill Gas	Argon	Argon
Window	Beryllium	Beryllium
Window Thickness	2 mil	2 mil
Window Diameter	0.5" (12.7mm)	1.00" (25.4mm)
Plateau Length	1400-1650 volts	1350-1600 volts
Typical Resolution	25% FWHM for Fe-55	25% FWHM for Fe-55

TENNELEC

CP Series High-Purity Coaxial P-Type Germanium Detector Systems

DESCRIPTION

TENNELEC's high-purity Coaxial Germanium detector systems are designed to provide the nuclear spectroscopist with the performance and reliability required for the detection and analysis of gamma radiation in the range of 40 keV to 10 MeV. These detector systems can be **stored indefinitely at room temperature** but are designed to operate at near liquid nitrogen temperature (77° Kelvin).

Each system consists of a high purity semiconductor germanium detector, Uniline vacuum cryostat, liquid-nitrogen dewar, charge-sensitive preamplifier and cable pack.

The **TENNELEC** CP series system contains a state-of-the-art **charge sensitive, cooled FET preamplifier**. The preamplifier and high-voltage filter network are encapsulated in a 3" diameter circular shroud that appears as an extension of the **Uniline cryostat** endcap. This feature eliminates external obstructing boxes and makes the **TENNELEC** Uniline cryostat system ideal for applications involving Compton suppression, lead or steel shields.

A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and **internally disables the high voltage** when the temperature rises to an unsafe level. **An LED illuminates red when this disabling circuit is activated**. This same **LED illuminates green when the system is cold** and bias may be applied.

A **High Count Rate LED** is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier.

TENNELEC's semiconductor germanium detectors are produced from **germanium crystals grown by TENNELEC** at our Oak Ridge, Tennessee facility. By producing our own crystals, **TENNELEC** has complete control over the quality, reliability and performance of the entire system.

- **Uniline designed cryostat**
- **Stored indefinitely at room temperature**
- **Unlimited recycles to room temperature**
- **High voltage internally disabled**
- **Charge-sensitive cooled FET preamplifier**
- **High rate LED**
- **"Red" warm, "Green" cold LED**
- **TENNELEC Produced Germanium**

SPECIFICATIONS AND FEATURES

EFFICIENCY This performance specification, most often referred to as the relative photopeak efficiency, is a measure of the photopeak count rate for the detector. It is called the Relative Photopeak Efficiency because it is the photopeak count rate of this detector as compared to a 3" x 3" NaI(Tl) detector's photopeak count rate for the Co-60, 1.332 MeV gamma peak with the source placed 25 cm from the end-cap face of the detector.

This performance specification is measured by the standard method that is described in the IEEE Test Procedures for Germanium Detectors for Ionizing Radiation [ANSI/IEEE 325-1971, (Reaff. 1977)].

RESOLUTION This specification defines the detector systems ability to separate closely-spaced peaks in a spectrum.

TENNELEC warrants the systems full-width-at-half-maximum (FWHM) resolution, including preamplifier contribution, for the 122 keV line of Co-57 and the 1.332 MeV line of Co-60. TENNELEC further warrants the full-width-at-tenth-maximum (FWTM) resolution as a ratio of the FWHM resolution. (See Fig. 1 and Fig. 4)

PEAK-TO-COMPTON RATIO The Peak-to-Compton ratio (P/C) is determined by comparing the average height of the Compton edge of a Co-60 spectrum from 1.040 to 1.096 MeV to the height of

the Co-60, 1.332 MeV peak. This specification describes the detectors ability to identify low-energy peaks in the presence of higher energy peaks. The Compton plateau results from gammas that deposit only a portion of their energies in the sensitive volume of the detector element. (See Fig. 1)

CRYOSTAT TENNELEC's Uniline vacuum cryostat is designed to provide many years of continuous, trouble-free operation. The cryostat is completely sealed and uses cryosorption pumping to maintain the vacuum. No external pumping is required.

The coaxial detector element is a closed-end true-right-circular-cylinder shape and is placed symmetrically in the center of the cryostat endcap with the front face of the crystal ≤5 mm from the front face of the endcap. This spacing increases the geometric efficiency of the detector system when the source is placed very near or on the endcap. (See Fig. 2)

DEWAR A 30 liter liquid-nitrogen dewar is provided with all TENNELEC CP Series detector systems. A liquid nitrogen transfer collar is supplied with inlet and outlet tubes for in-situ filling.

PREAMPLIFIER The TENNELEC CP series system contains a state-of-the-art charge sensitive, cooled FET preamplifier. The preamplifier and high-voltage filter network are encapsulated in a 3" diameter circular shroud that appears as an extension of the Uniline cryostat encap. This feature eliminates external obstructing boxes and makes the TENNELEC Uniline cryostat system ideal for applications involving Compton suppression, lead or steel shield.

A temperature sensing circuit has been built into the preamplifier electronic package. This circuit is very sensitive to the temperature of the detector element and internally disables the high voltage when the temperature rises to an unsafe level. An LED illuminates red when this disabling circuit is activated. This same LED illuminates green when the system is cold and bias may be applied. (See Fig. 3)

A High Count Rate LED is also provided and illuminates when the count rate of the system exceeds the capability of the preamplifier. (See Fig. 3)

A cable pack is provided with all TENNELEC CP Series Systems. Included are a coaxial high voltage cable (SHV female to SHV female, RG-59A/U, 75 ohm) and a preamplifier power cable. The preamplifier power cable contains three (3) RG-174, 50 ohm coaxial cables. When

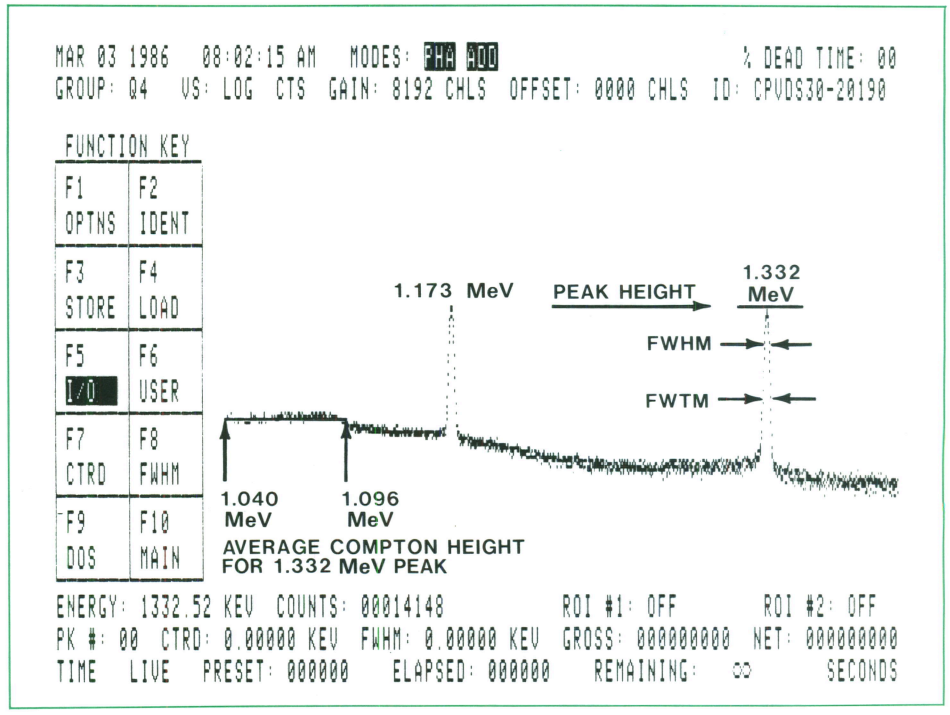


Figure 1 Typical spectral response of TENNELEC CP Series Detector System to Co-60 gamma rays.

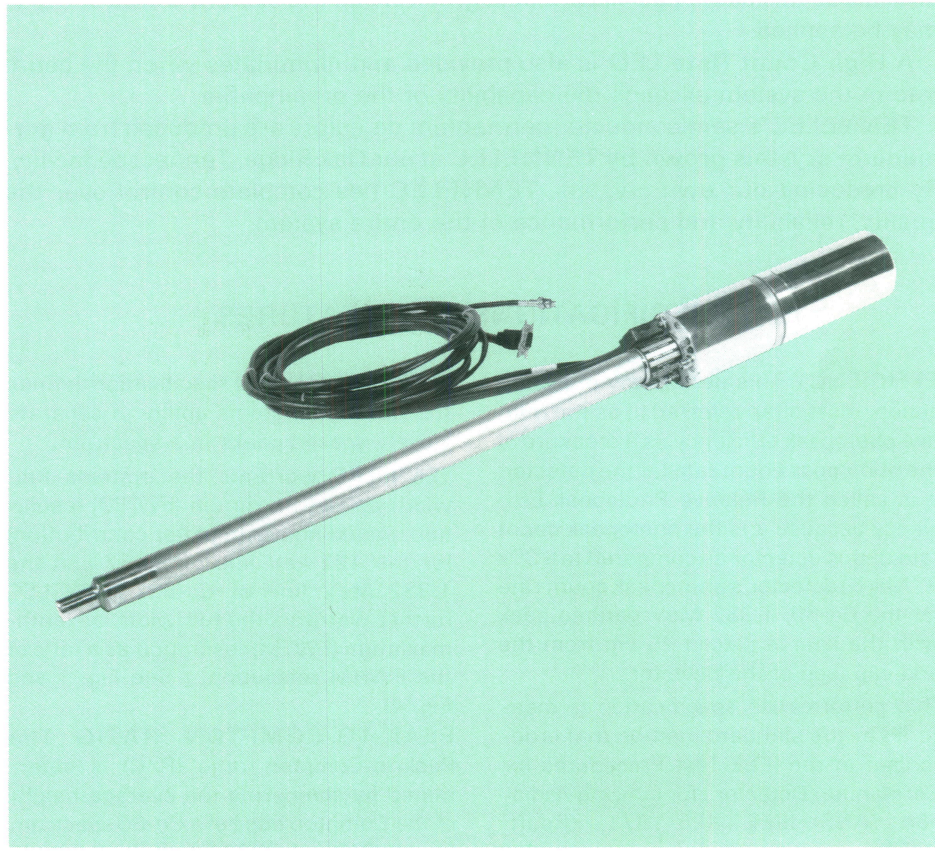


Figure 2 TENNELEC's Vertical Dipstick Uniline Cryostat.

connected to and powered by a TENNELEC amplifier, such as the TC 244, one cable carries the signal from the detector preamplifier to the amplifier; the second is for the Differential input to TENNELEC amplifiers; and the third carries test pulses routed through the amplifier to the preamplifier.

MODEL NUMBER The TENNELEC model number fully describes the detector system in the following format.

AABBBCC-XXYYY/ZZ

AA type of detector
- CP = P-type coax
- CN = N-type coax
- WP = P-type well
- PL = Planar detector

BBB type of cryostat
- VDS = Vertical dipstick
- HDS = Horizontal dipstick
- VDL = Vertical down looking
- HSL = Horizontal side looking

CC dewar volume
- 30 = 30 liter
- 15 = 15 liter
- 75 = 7.5 liter

XX efficiency in percent for coax or diameter in millimeters for planar detectors (refers to AA)

10 = 10%	36 = 36mm
15 = 15%	44 = 44mm
20 = 20%	51 = 51mm

etc.

YYY resolution in keV for coax detectors for Co-60, 1.332 MeV gamma and in eV for planar detectors for Fe-55, 5.9 keV X-ray (refers to AA)
- 185 = 1.85 keV
- 190 = 1.90 keV
- 165 = 165 eV
- 180 = 180 eV

etc.

ZZ optional — for depth of planar detectors in millimeters
- 10 = 10mm
- 13 = 13mm
- 15 = 15mm

EXAMPLE:

C P V D S 3 0 - 2 5 1 8 5

- C P: P-Type Coax
- V D S: Vertical dipstick Cryostat
- 3 0: 30 liter dewar
- 2 5: 25% efficiency
- 1 8 5: 1.85 keV resolution @ 1.332 MeV

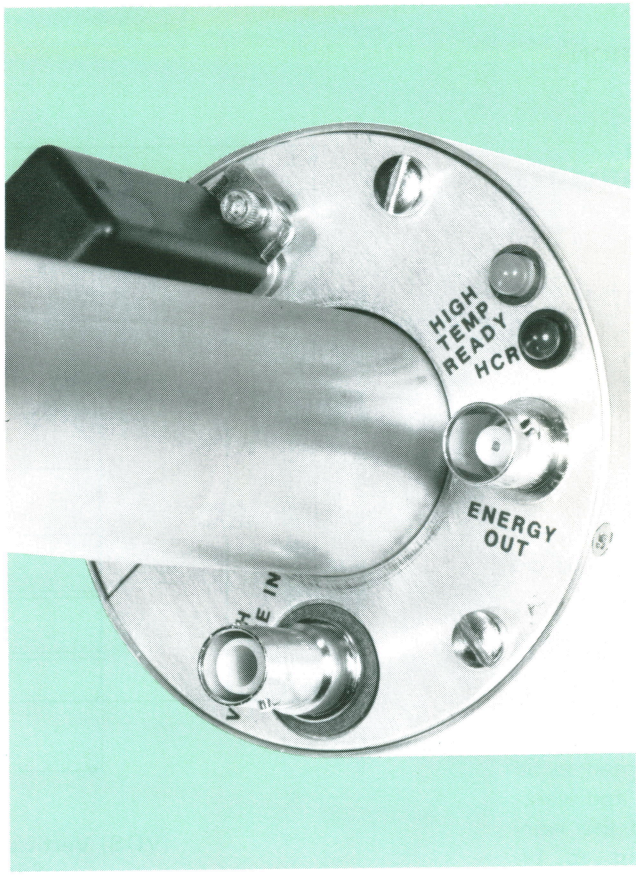


Figure 3 Bottom view of TENNELEC's Uniline Cryostat Preamplifier.

Efficiency %	Resolution 1.332 MeV (keV)	Resolution 122 keV (eV)	P/C Ratio	FWTM/FWHM Ratio
10	1.75	825	41:1	1.90
10	1.85	900	39:1	1.95
10	1.95	1000	37:1	2.00
15	1.80	825	46:1	1.90
15	1.90	900	44:1	1.95
15	2.00	1000	41:1	2.00
20	1.80	850	51:1	1.90
20	1.90	925	48:1	1.95
20	2.00	1100	46:1	2.00
25	1.85	850	55:1	1.90
25	1.95	925	52:1	1.95
25	2.10	1100	48:1	2.00
30	1.85	875	58:1	1.90
30	1.95	950	56:1	1.95
30	2.10	1200	52:1	2.00

Figure 4 Performance Specifications for CP Series Detector Systems.

ORDERING INFORMATION

SYSTEM WEIGHTS

VERTICAL DIPSTICK SYSTEM
(Net) 36 lbs. (16.4 kg)
(With LN_2) 89 lbs. (40.5 kg)
(Shipping) 53 lbs. (24.1 kg)

HORIZONTAL DIPSTICK SYSTEM
(Net) 41 lbs. (18.6 kg)
(With LN_2) 94 lbs. (42.7 kg)
(Shipping) 60 lbs. (27.3 kg)

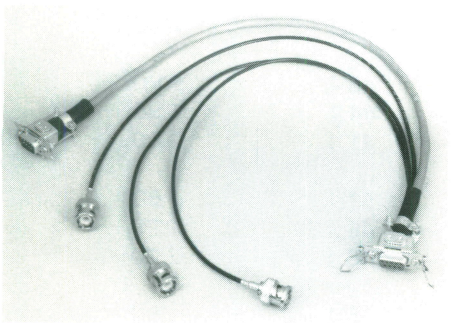
SHIPPING CARTON SIZES

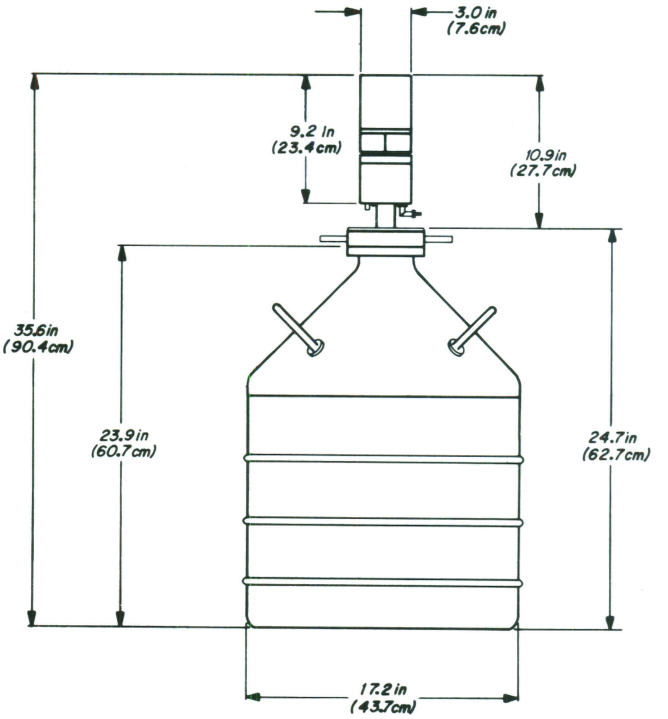
(includes wooden pallet)
VERTICAL DIPSTICK SYSTEM
24" x 24" x 52"
61 cm x 61 cm x 132 cm

HORIZONTAL DIPSTICK SYSTEM
24" x 30" x 52"
61 cm x 76 cm x 132 cm

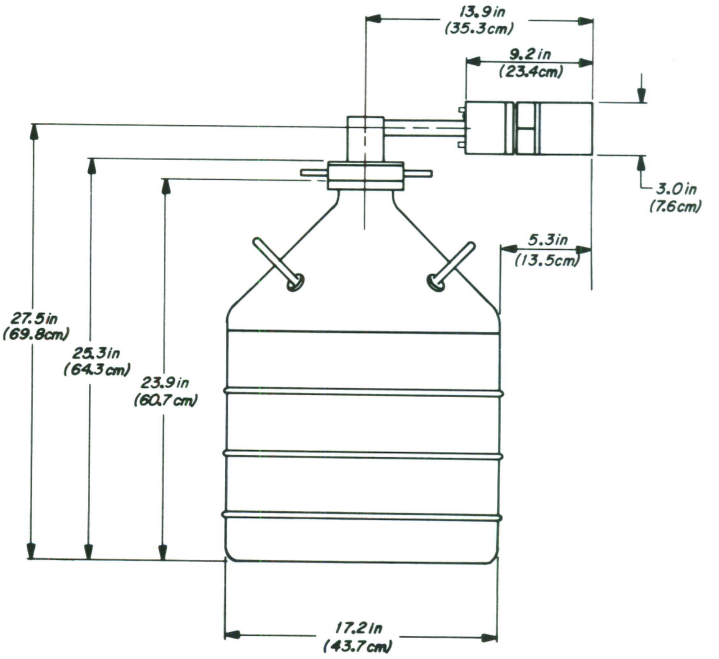
WARRANTY TENNELEC CP Series Detector Systems are warranted to be free from defects in material and workmanship, to meet or exceed the warranted specifications and to be recyclable from liquid nitrogen to room temperature an indefinite number of times for a period of one (1) year.

ACCESSORIES AVAILABLE An ADT-2 Preamp power cable adapter is available for systems that are interfaced to amplifiers other than TENNELEC. This adapter brings the Signal, Differential and Test lines from the TENNELEC power cable out to male BNC connectors.





(VDS) Vertical Dipstick System Side View



(HDS) Horizontal Dipstick System Side View

TENNELEC INC.
TENNELEC, Inc., 601 Oak Ridge Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, U.S.A.
PHONE 615-483-8405 TWX 810-572-1018

CP Series 10.0K 986

GDR-PC *Gamma Data Reduction Software for The Nucleus Personal Computer Analyzer*

INTRODUCTION

GDR-PC is a complete software package for automatic qualitative and quantitative analysis of gamma spectra from germanium detectors. The program is designed to run on IBM-PC, XT, AT and compatible personal computers in conjunction with Nucleus Personal Computer Analyzer.

Developed exclusively for The Nucleus by Quantum Technology of Atlanta, GA, GDR-PC provides accurate nuclide identification using personal computers. Written in compiled C, the software operates under DOS 2.0 or later, on systems with as little as 256K of memory without the need for hard disk program storage.

FEATURES:

- Menu driven
- Cross correlation Peak Search with editing
- Automatic multiplet gaussian fitting
- Multiple resolution, energy and efficiency files
- Isotope identification and activity calculation with decay correction
- Minimum detectable activity calculation and reporting
- Self calibration
- Custom nuclide libraries with editor

PEAK SEARCH

The cross correlation peak search is used to determine each peak in the spectrum. The entire spectrum (up to 8192 channels) or any part of the spectrum may be analyzed using this method to locate all of the peaks automatically.

The cross correlator method is a very well behaved method for determining peak regions of interest. (Reference "Application of Correlation Techniques to Isolate Structure in Experimental Data", W. W. Black, Nuclear Instrument and Methods, 71, 317-327, 1969)

The sensitivity of the correlator calculations is controlled by a multiplicative factor equal to the number of standard deviations a peak must rise above background before the correlator will indicate a peak is present. The correlator calculation allows even very small peaks to be detected against a widely varying background. But because the value of the correlator accounts for the variance of the spectrum data, the extremely noisy background often found at high energies does not result in errant peak identification.

Once all of the peak locations are determined, a background line is established for each peak. If the background areas of adjacent peaks overlap with the start or end channels, then the peaks are treated as a multiplet and the remaining peak calculations are done after a gaussian curve fit to the data. Up to five peaks in a multiplet may be handled by the software.

The peak search calculations include the following:

1. Peak Centroid (weighted sum calculation)
2. Peak Gross, Background, and Net Counts
3. Peak Critical Level counts and Peak Width

For simple spectra the entire process, from peak identification to peak data calculations, requires less than 3 minutes for an 8000 channel spectrum (with 8087 math co-processor) on a regular IBM PC. The number of peaks allowed in a spectrum is unlimited depending only on the memory available in the PC. Once the data for each peak has been calculated, the user may then choose to print the results on the screen, the printer, or to a file. Unwanted peaks may be deleted from the peak search report to aid in the analysis.

```
*****************************************************************************
                          Quantum Technology
                        GDR_C   Version V1.0
*****************************************************************************

Sample ID :      AMSTD-10.SPM            Sample Size : 1.00E+00 CC

Sampling Start :  6-03-86 17:00           Sampling Stop :  6-03-86 17:00

Counting Start :  6-03-86 17:00           Current Date  :  7-17-86 16:06

Live Time :        10000 Sec

Detector # 1

Energy(keV)=  2.23 +   0.367*Ch + -2.21E-07*Ch^2 + 2.35E-11*Ch^3  6-03-86 17:00

FWHM(keV)  =  1.11 +  -0.001*En +  8.56E-04*En^2 + 0.00E+00*En^3  6-13-86 14:00
              Where En = Sqrt(Energy in keV)

Sensitivity : 1.00                        Search Start / End :  100 / 8191
```

PK. #	ENERGY (keV)	ADDRESS CHANNEL	NET COUNTS	UN-CERTAINTY	C.L. COUNTS	BKG COUNTS	CH IN PEAK	FLAG
1	88.05	233.91	808364	1320	1991	205411	11	
2	122.04	326.56	909865	1499	2493	190860	12	
3	136.37	365.65	115525	785	1346	166764	12	
4	165.84	445.99	777173	1318	2066	174857	13	
5	255.13	689.47	47979	1155	2472	160825	14	
6	279.18	755.08	402278	922	1289	141223	13	
7	391.70	1061.99	963502	1164	1206	123682	13	
8	513.97	1395.60	736414	1050	1180	109968	14	
9	661.65	1798.66	1342861	1313	1215	108807	15	
10	814.00	2214.52	17275	525	1009	70355	16	
11	898.03	2443.92	968302	1152	1198	93313	17	
12	1173.21	3195.27	851509	1036	950	55410	18	
13	1325.03	3609.79	17447	366	691	28320	15	a
14	1332.47	3630.10	759086	933	675	28129	15	b
15	1836.10	5004.81	506024	773	620	20226	21	
16	2222.54	6058.76	1632	328	722	9949	28	
17	2506.23	6831.74	26753	312	595	5225	25	
18	2735.12	7454.77	23354	201	295	1188	27	

FIG. 1a
Peak Search Results

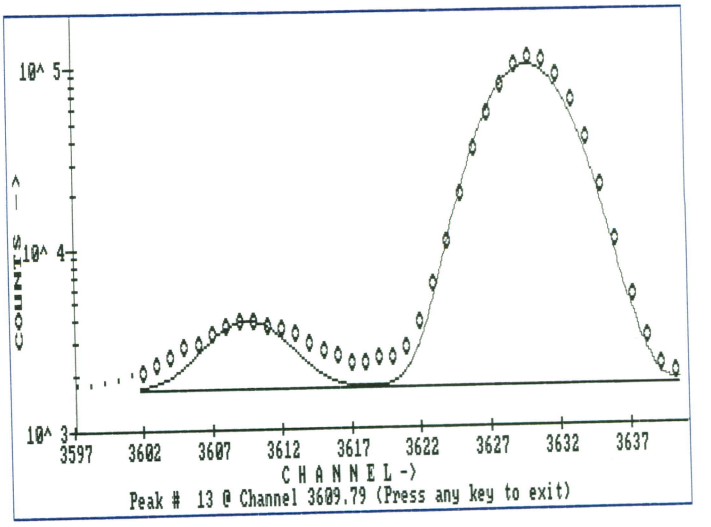


FIG. 1b
Multiplet Fitting

PEAK IDENTIFICATION AND ACTIVITY CALCULATIONS

Once the peak search has been run on a particular spectrum and the peaks located, they may be identified and activity calculations performed by comparing the results against a nuclide library and detector efficiency file.

Any nuclides marked for Minimum Detectable Activity (MDA) in the nuclide library, but not found in the peak search, will have an MDA calculated. Nuclides found with more than one peak will have an average activity calculated. Peaks not listed in the library, but found in the spectrum by the peak search are listed as unknown peaks. Activities are decay corrected. The user may elect to send the results of these calculations to the screen, printer, or a file. The efficiency calibration equation and parameters, and all user defined activity calculation parameters (e.g. peak energy vs. library energy tolerance) are also included in this report.

```
*****************************************************************************
                          Quantum Technology
                   GDR_C Nuclide Activity Summary
*****************************************************************************

Library File: GDRLIB.DAT


Efficiency file: TENNEFF.DAT

ID.: DISC

Eff.=1/[ 3.92E-03*En^-2.98E+00 +  3.75E+01*En^ 1.10E+00]          5-28-86 17:00
     (Where En = Energy in MeV)
```

Nuclide	Energy (keV)		Concentration (uCi/CC)		Halflife (hrs)	Peaks Found
La-140	Average:		6.35E-03 +- 1.93E-04		4.02E+01	1 of 2
	1596.49	(	4.39E-04	MDA		
	815.85		6.35E-03 +- 1.93E-04			
Zn-65	1115.52	(	5.03E-04	MDA	5.86E+03	
Fe-59	1099.22	(	7.79E-04	MDA	1.07E+03	0 of 2
Rb-86	1076.63	(	2.75E-03	MDA	4.48E+02	
Mn-54	834.83	(	2.86E-04	MDA	7.50E+03	
Cs-136	818.50	(	3.91E-04	MDA	3.14E+02	0 of 3
Co-58	810.75	(	3.59E-04	MDA	1.70E+03	0 of 2
Nb-95	765.83	(	3.19E-04	MDA	8.44E+02	
Zr-95	756.74	(	5.69E-04	MDA	1.54E+03	0 of 2
Te-129m	695.98	(	1.76E-02	MDA	8.06E+02	0 of 2
Ag-110m	657.75	(	7.70E-04	MDA	6.02E+03	0 of 4
Ru-106	621.80	(	2.98E-03	MDA	8.84E+03	
Cs-134	604.70	(	1.64E-04	MDA	1.81E+04	0 of 3
Sb-124	602.72	(	2.84E-04	MDA	1.44E+03	0 of 2
Ba-140	537.32	(	1.23E-03	MDA	3.07E+02	
Ru-103	497.08	(	2.90E-04	MDA	9.44E+02	
Sb-125	427.90	(	7.84E-04	MDA	2.38E+04	0 of 4
I-131	364.48	(	2.47E-04	MDA	1.93E+02	0 of 3
Ba-133	356.92	(	3.18E-04	MDA	9.34E+04	0 of 3
Cr-51	320.08	(	1.88E-03	MDA	6.65E+02	
Ce-141	145.44	(	1.33E-04	MDA	7.80E+02	
Ce-144	133.53	(	1.48E-03	MDA	6.82E+03	0 of 2
Cd-109	88.03		4.74E-01 +- 7.75E-04		1.11E+04	1 of 1
Co-57	Average:		1.66E-02 +- 2.65E-05		6.50E+03	2 of 2
	122.06		1.66E-02 +- 2.73E-05			
	136.48		1.67E-02 +- 1.13E-04			
Ce-139	165.85		1.57E-02 +- 2.66E-05		3.30E+03	1 of 1
Hg-203	279.19		I.D.Only			
Sn-113	391.69		5.45E-02 +- 6.59E-05		2.76E+03	1 of 1
Cs-137	661.65		1.01E-01 +- 9.91E-05		2.64E+05	1 of 1
Rb-88	Average:		3.42E+00 +- 3.24E-03		2.96E-01	2 of 2
	898.03		3.91E+00 +- 4.65E-03			
	1836.00		2.95E+00 +- 4.51E-03			
Co-60	Average:		1.04E-01 +- 9.01E-05		4.62E+04	2 of 2
	1173.21		1.03E-01 +- 1.25E-04			
	1332.46		1.06E-01 +- 1.30E-04			

UNKNOWN PEAKS

Energy (keV)	Centroid Channel	Net Counts	Un-Certainty	C.L. Counts	Bkg. Counts	Ch in Peak
255.13	689.47	47979	1155	2472	160825	14
513.97	1395.60	736414	1050	1180	109968	14
1325.03	3609.79	17447	366	691	28320	15
2222.54	6058.76	1632	328	722	9949	28
2506.23	6831.74	26753	312	595	5225	25
2735.12	7454.77	23354	201	295	1188	27

FIG. 2
Nuclide Identification Report

CUSTOM NUCLIDE LIBRARIES

A nuclide library editor is included to allow users to create custom nuclide libraries for different applications and measurements. Individual libraries may be constructed for analyzing different types of samples. Nuclides may be readily added to or removed from a library. Each gamma energy is listed as MDA, BKG, QUANT or ID type for later identification.

Library file: GDRLIB.DAT

ID.: GDR/C Standard Kocher-based library

Pk. #	Energy (keV)	Isotope Name	2ndary Pk #	Type	Gamma Fraction	Halflife (Hours)
1	80.12	Ce-144	4	I.D.	0.0164	6.8230E+03
2	88.03	Cd-109	0	MDA	0.0372	1.1136E+04
3	122.06	Co-57	5	MDA	0.8559	6.5196E+03
4	133.53	Ce-144	1	MDA	0.1080	6.8232E+03
5	136.48	Co-57	3	QUANT	0.1061	6.5016E+03
6	145.44	Ce-141	0	MDA	0.4800	7.8000E+02
7	165.85	Ce-139	0	MDA	0.8035	3.3038E+03
8	176.29	Sb-125	18	I.D.	0.0670	2.4282E+04
9	279.19	Hg-203	0	I.D.	0.7730	1.1184E+03
10	284.30	I-131	15	I.D.	0.0605	1.9296E+02
11	293.26	Ce-143	0	QUANT	0.4340	3.3000E+01
12	302.86	Ba-133	14	QUANT	0.1820	9.3450E+04
13	320.08	Cr-51	0	MDA	0.0980	6.6489E+02
14	356.92	Ba-133	16	MDA	0.6200	9.3450E+04
15	364.48	I-131	30	MDA	0.8120	1.9296E+02
16	383.85	Ba-133	12	QUANT	0.0870	9.3500E+04
17	391.69	Sn-113	0	MDA	0.6400	2.7617E+03
18	427.90	Sb-125	25	MDA	0.2950	2.3760E+04
19	497.08	Ru-103	0	MDA	0.8640	9.4440E+02
20	522.65	I-132	41	I.D.	0.1610	2.3000E+01
21	529.89	I-133	50	QUANT	0.8730	2.0800E+01
22	536.09	I-130	33	QUANT	0.9900	1.2360E+01
23	537.32	Ba-140	0	MDA	0.2040	3.0694E+02
24	569.31	Cs-134	27	I.D.	0.1543	1.8076E+04
25	600.60	Sb-125	29	QUANT	0.1760	2.3760E+04
26	602.72	Sb-124	69	MDA	0.9792	1.4448E+03
27	604.70	Cs-134	43	MDA	0.9760	1.8075E+04
28	621.80	Ru-106	0	MDA	0.0980	8.8368E+03
29	636.00	Sb-125	8	I.D.	0.1130	2.3760E+04
30	636.97	I-131	10	QUANT	0.0726	1.9296E+02
31	657.75	Ag-110m	51	MDA	0.9339	6.0192E+03
32	661.65	Cs-137	0	MDA	0.8514	2.6447E+05
33	668.54	I-130	22	QUANT	0.9610	1.2360E+01
34	695.98	Te-129m	36	MDA	0.0112	8.0640E+02
35	724.23	Zr-95	39	QUANT	0.4450	1.5355E+03
36	729.62	Te-129m	34	I.D.	0.0026	8.0640E+02
37	739.48	Mo-99	42	QUANT	0.1300	6.6020E+01
38	743.36	Zr-97	60	QUANT	0.9267	1.6900E+01
39	756.74	Zr-95	35	MDA	0.5500	1.5355E+03
40	765.83	Nb-95	0	MDA	1.0000	8.4360E+02
41	772.60	I-132	54	I.D.	0.7620	2.3000E+01
42	777.88	Mo-99	37	I.D.	0.0462	6.6020E+01
43	795.84	Cs-134	24	QUANT	0.8540	1.8075E+04
44	810.75	Co-58	49	MDA	0.9945	1.6992E+03
45	815.85	La-140	68	QUANT	0.2250	4.0220E+01
46	818.50	Cs-136	55	MDA	0.9970	3.1440E+02
47	834.83	Mn-54	0	MDA	0.9997	7.5000E+03
48	852.21	Te-131m	59	QUANT	0.2090	3.0000E+01
49	863.94	Co-58	44	QUANT	0.0068	1.6992E+03
50	875.37	I-133	21	QUANT	0.0440	2.0900E+01
51	884.68	Ag-110m	53	QUANT	0.7202	6.0192E+03
52	898.03	Rb-88	70	QUANT	0.1450	2.9600E-01
53	937.48	Ag-110m	67	QUANT	0.3394	6.0192E+03

FIG. 3
Nuclide Library

ENERGY, RESOLUTION & EFFICIENCY CALIBRATIONS

The GDR-PC analysis software includes automatic calibration routines which allow the user to calibrate the spectroscopy system for energy, resolution and efficiency using standard reference sources. An editor is provided for creating a standards file for each reference source. The file contains the peak energy value, disintegrations/second, branching ratio and half life for each nuclide in the source.

```
*****************************************************************************
                          Quantum Technology
                   GDR_C  Detector Calibration
*****************************************************************************


Detector # :  1                        Source Fraction: 1.000000

Standards file: GDRSTD01.DAT

Assay Date:  2-01-86 12:00

ID.: QCD.1 S/N 11080B
```

Pk #	Name	Energy	Halflife (hrs)	Br.Ratio	dps/gm
1	Cd-109	88.03	1.087E+04	1.00000	770
2	Co-57	122.06	6.502E+03	1.00000	703
3	Co-57	136.47	6.502E+03	1.00000	89
4	Ce-139	165.85	3.300E+03	1.00000	848
5	Hg-203	279.19	1.118E+03	1.00000	2274
6	Sb-113	391.70	2.760E+03	1.00000	2630
7	Sr-85	514.00	1.555E+03	1.00000	4703
8	Cs-137	661.64	2.645E+05	1.00000	2945
9	Yt-88	898.00	2.558E+03	1.00000	7363
10	Co-60	1173.20	4.620E+04	1.00000	4030
11	Co-60	1332.50	4.620E+04	1.00000	4034
12	Yt-88	1836.10	2.558E+03	1.00000	7850

FIG. 4a
Standards File

The software performs a match of those peaks found in the calibration spectrum against those listed in the standards file. The user is given the option of deleting any matched energy pairs prior to performing the curve fit necessary to establish the coefficients of the energy calibration equation. The fit is then performed, and a report showing goodness of fit is presented.

The user may then store the results in the detector file being used.

The equation used for the energy calibration curve is a third order polynomial equation of the form:

$$\text{Energy (keV)} = a + bCh + cCh^2 + dCh^3$$

where a, b, c, d are the four coefficients of the equation and Ch is the spectrum channel.

This curve is then used for determining the peak centroid energy values in all peak searches using the specified detector.

Detector #: 1

Energy(keV)= 2.27 + 0.367*Ch +-2.06E-07*Ch^2 + 2.20E-11*Ch^3

Pk. #	Measured Centroid	Calculated Energy	Energy (keV)	% Difference
1	233.91	88.08	88.03	0.06
2	326.56	122.06	122.06	0.00
3	365.65	136.40	136.47	-0.05
4	445.99	165.86	165.85	0.01
5	755.08	279.20	279.19	0.00
6	1061.99	391.70	391.70	0.00
7	1395.60	513.97	514.00	-0.01
8	1798.66	661.65	661.64	0.00
9	2443.92	898.02	898.00	0.00
10	3195.27	1173.21	1173.20	0.00
11	3630.10	1332.47	1332.50	-0.00
12	5004.81	1836.10	1836.10	0.00

Energy coefficients stored on GDRDET01.DAT.

FIG. 4b
Energy Calibration

The Resolution Calibration feature of the software allows the user to calibrate the full width at half-maximum (FWHM) for each peak in a calibration spectrum for which an energy calibration has been performed.

The computer performs a gaussian fit of each peak in the calibration spectrum and determines the FWHM at each peak centroid. The user has the option to delete any peak pairs that he does not wish to be used for determining the resolution calibration curve (e.g. sum or 511 KeV annihilation peaks). The data pairs are then fitted to a third order polynomial curve of the form:

$$\text{FWHM (keV)} = a + b\chi + c\chi^2 + d\chi^3$$

where a, b, c, d are the four coefficients of the equation and χ is the square root of the energy in keV.

This curve is used for determining the FWHM for all peaks across the spectrum. The FWHM is utilized in the correlator search window width computation to aid in confirming singlet peaks during the spectrum search, and for initial estimates of peak width for peaks within a multiplet.

Detector #: 1

FWHM(keV)= 1.13 + 0.007*En + 6.87E-04*En^2 + 0.00E+00*En^3
(Where En = SQR(Energy in keV))

Pk. #	Energy (kev)	Measured FWHM(keV)	Calculated FWHM(keV)	% Difference
1	88.03	1.25	1.26	0.16
2	122.06	1.29	1.29	-0.15
3	136.47	1.31	1.30	-0.12
4	165.85	1.33	1.33	0.03
5	279.19	1.44	1.44	-0.20
6	391.70	1.53	1.53	0.01
7	514.00	1.64	1.64	-0.19
8	661.64	1.74	1.76	0.84
9	898.00	1.95	1.95	0.01
10	1173.20	2.16	2.17	0.29
11	1332.50	2.31	2.29	-1.03
12	1836.10	2.67	2.68	0.33

FWHM coefficients stored on GDRDET01.DAT.

FIG. 4c
Resolution Calibration

The Efficiency Calibration feature allows the user to create a geometry file which contains the calibration date, type of efficiency calibration performed (e.g. point source, Marinelli, etc.), and the coefficients of the calibration equation used. The user must specify a standards file which corresponds to the standard used to create the spectrum and use a detector for which an energy and resolution calibration have been performed. The efficiency curve for the detector is determined by performing a peak search on the calibration spectrum, matching those peaks found with the ones in the standards files, and comparing the net counts found by the peak search for each peak with the expected net counts as calculated from the information contained in the standards file (e.g. DPS, branching ratio) after decay correction. The user may then store the results in a geometry file.

There are two types of fits that may be performed on efficiency data, a polynomial fit and an exponential fit. This is to provide the user with enhanced capabilities for various geometries. The exponential fit is most commonly used. The equations used for the efficiency calibration are as follows:

1. Polynomial

$$\text{Efficiency} = \frac{1}{a\chi^b + c\chi^d}$$

where a, b, c, d are the four coefficients of the equation and χ is the energy in keV.

2. Exponential

$$\text{Efficiency} = 10^{(a + b\chi + c\chi^2 + d\chi^3)}$$

where a, b, c, d are the four coefficients of the equation and χ is the log base 10 of the energy in keV.

This curve is then used for determining the peak centroid energy values in all peak searches using the specified detector. A plotting routine is included to output the efficiency curve to the graphics printer.

Detector #: 1

Geometry File : TENNEFF.DAT I.D. : DISC

Eff.=1/[5.63E-03*En^-2.83E+00 + 3.67E+01*En^ 1.11E+00]
(Where En = Energy in MeV))

Pk. #	Energy (kev)	Measured Efficiency	Calculated Efficiency	% Difference
1	88.03	1.27E-01	1.27E-01	0.20
2	122.06	1.77E-01	1.75E-01	-0.90
3	136.47	1.77E-01	1.79E-01	0.82
4	165.85	1.70E-01	1.70E-01	-0.05
5	279.19	1.09E-01	1.10E-01	0.84
6	391.70	7.65E-02	7.67E-02	0.26
7	514.00	5.79E-02	5.70E-02	-1.55
8	661.64	4.59E-02	4.31E-02	-6.59
9	898.00	2.91E-02	3.07E-02	5.30
10	1173.20	2.21E-02	2.29E-02	3.37
11	1332.50	1.97E-02	1.98E-02	0.89
12	1836.10	1.43E-02	1.39E-02	-2.62

FIG. 4d
Efficiency Calibration

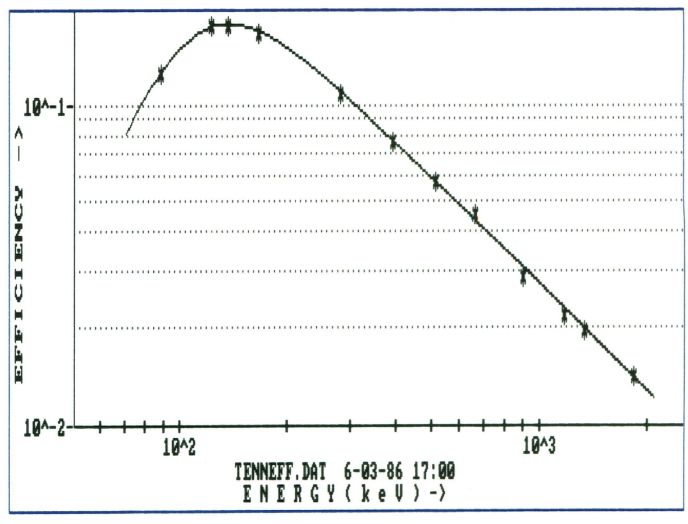


FIG. 5
Detector Efficiency curve

Personal Computer Analyzer Systems

the Nucleus® INC.

761 EMORY VALLEY ROAD
OAK RIDGE, TN 37831-2561
TELEPHONE 615-482-4041 • TLX 557-482

TENNELEC

TC 244
Amplifier/Pileup Rejecto
Live Time Correcto

DESCRIPTION

The TENNELEC Model TC 244 represents the latest quantum technology breakthrough in the field of nuclear pulse spectroscopy. The TC 244 is the **first commercially available spectroscopy amplifier with triangular shaping and internal pulse pileup rejection.** A new technique of pileup rejection, based upon research conducted by the University of California Lawrence Berkeley Laboratories, enables the TC 244 to give up to 35% **higher throughput/count rate capability.** This breakthrough **dramatically reduces ADC deadtime at high counting rates.** Better pulse-pair resolution is obtained because the unipolar output pulse no longer must return to baseline before the pileup rejector resets. These features make the TC 244 the new standard amplifier of choice for the discriminating spectroscopist. The TC 244 is also useful for germanium planar and silicon x-ray detectors, silicon surface barrier detectors, scintillation detectors, proportional counters, and pulsed ion chambers. For any application requiring high throughput and maximum resolution, the TC 244 is the amplifier of choice.

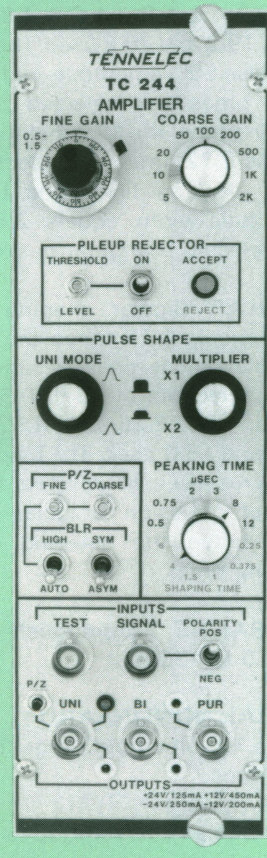
Twenty-four (24) front-panel selectable peaking times give the spectroscopist the ability to optimize resolution and throughput considerations. In addition, the TC 244 offers both **triangular and semi-gaussian pulse shaping.** For most applications the triangular shaping will give better results due to its wider output pulse and better signal-to-noise ratio.

An automatic **gated baseline restorer (BLR)** with **automatic restoration rate** provides high count rate performance without sacrificing resolution at low count rates, while the automatic threshold adjusts as a function of input noise. A SYMmetrical and ASYMmetrical BLR switch allows the user to optimize performance for detector systems having excessive noise, secondary preamplifier time constants, or pulsed reset preamplifiers.

LED indicators allow the user to verify performance of the TC 244 at a glance. TENNELEC's **exclusive bi-color pileup rejector LED** indicator appears green for 0 to approximately 40% pulse pileup rejection, yellow for 40-70% rejection, and red for 70% and above. The **Unipolar output LED** indicator illuminates to indicate signals are being processed through the amplifier.

The TC 244 **may be used with reset transistor or pulsed optical preamplifiers** without complicated interfaces or connections. When used with TENNELEC preamplifiers, the TC 244 accepts signals from the preamplifier and supplies a test input pulse to the preamplifier without any additional external cabling between the TC 244 and the preamplifier. Three high-quality RG-174 coaxial cables are incorporated into the TENNELEC preamplifier power cable and our **exclusive "one cable preamplifier connection"** eliminates the need for conventional cabling.

- **First commercially available spectroscopy amplifier with triangular shaping and internal pulse pileup rejection**
- **Higher throughput/count rate capability**
- **Dramatically reduces ADC deadtime at high counting rates**
- **Twenty-four (24) front-panel selectable peaking times**
- **Choice of triangular or semi-gaussian pulse shaping**
- **Gated baseline restorer (BLR) with automatic threshold and restoration rate**
- **Exclusive bi-color pileup rejector LED indicator**
- **Unipolar output LED indicator**
- **May be used with reset transistor or pulsed optical preamplifiers**
- **Exclusive "one cable preamplifier connection"**



TENNELEC INC.
PHONE 615-483-8405 TWX 810-572-1018

INNOVATION TO MAKE IT FIRST . . . RELIABILITY TO MAKE IT LAST

TC 244 Amplifier

SPECIFICATIONS

PERFORMANCE

PULSE SHAPING Active eight-pole shaping network produces either triangular or near-gaussian shaped unipolar pulses along with bipolar shaped pulses.

GAUSSIAN UNIPOLAR Selectable peaking times of 0.5, 0.75, 1, 1.5, 2, 3, 4, 6, 8, 12, 16 and 24 μsec are available in the gaussian mode. The gaussian pulse 50% amplitude-width equals the selected gaussian peaking time, the 1% amplitude-width equals 2.44 times the selected gaussian peaking time, and the 0.1% amplitude-width equals 2.89 times the selected gaussian peaking time.

TRIANGULAR UNIPOLAR Triangular shaping peaking time equals 1.20 times the selected gaussian mode peaking time, resulting in selections of 0.6, 0.9, 1.2, 1.8, 2.4, 3.6, 4.8, 7.2, 9.6, 14.4, 19.2 and 28.8 μsec. The triangular pulse 50% amplitude-width equals 1.05 times the selected triangular peaking time, the 1% amplitude-width equals 2.32 times the selected triangular peaking time, and the 0.1% amplitude-width equals 2.65 times the selected triangular peaking time.

BIPOLAR Bipolar shaping peaking time equals 0.75 times the selected gaussian mode peaking time, resulting in selections of 0.375, 0.563, 0.75, 1.125, 1.50, 2.25, 3.0, 4.5, 6.0, 9.0, 12.0 and 18.0 μsec. The bipolar pulse zero-crossover is delayed from the prompt gaussian unipolar peak by 0.15 times the selected gaussian peaking time.

GAIN RANGE Continuously variable from X2.5 to X3000.

INTEGRAL NONLINEARITY ≤±0.04% over 0 to 10 volt output range for 4 μsec peaking time.

NOISE ≤4.5 μV rms referred to the input for 4 μsec peaking time, gaussian unipolar shaping and gain of 1000; typically ≤4.0 μV rms for gains ≥100. Bipolar typically ≤6.8 μV rms for 4 μsec peaking time and gains ≥100.

TEMPERATURE INSTABILITY

UNIPOLAR
- Gain ≤±0.005%/°C, 0 to 50°C
- DC Level ≤±7.5 μV/°C, 0 to 50°C

PUR
- Gain ≤±0.007%/°C, 0 to 50°C
- DC Level ≤±50 μV/°C, 0 to 50°C

BIPOLAR
- Gain ≤±0.007%/°C, 0 to 50°C
- DC Level ≤±30 μV/°C, 0 to 50°C

WALK ≤±3 nsec over a 50:1 dynamic range for 4 μsec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from X1000 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from X1000 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

SPECTRUM BROADENING (Unipolar) Typically less than 10% change of FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

SPECTRUM SHIFT (Unipolar) Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 4 μsec peaking time and incoming count rates to 100k cps.

PILEUP INSPECTOR RESOLVING TIME Typically 250 nsec.

LIVE TIME CORRECTION Typically less than +0/−10% change in ^{60}Co reference peak area in the presence of a 0 to 75k cps ^{137}Cs interfering source at 4 μsec peaking time.

LOSS FREE COUNTING MODE Provides real time compensation of amplifier, pileup rejector, and ADC counting losses when used with an external Loss Free Counting (LFC) module.

OPERATING TEMPERATURE 0 to 50°C

CONTROLS

COARSE GAIN Nine-position rotary switch selects gain factors from 5 to 2000 in a 1-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN control extends the total gain range from 2.5 to 3000.

PILEUP REJECTOR

Threshold Level Multi-turn screwdriver adjustable control for setting the threshold level of the pulse pileup inspector. Variable from 0 to 1 volt.

On-Threshold-Off Three-position toggle switch selects pileup rejector mode. In the ON position the PUR output is enabled and the bicolor LED Accept/Reject indicator shows relative pileup rate. Threshold position disables the PUR output, DT output and the bi-color operation of the ACCEPT/REJECT indicator allowing the THRESHOLD control to be accurately adjusted by monitoring the red REJECT indicator. OFF totally disables both the PUR and ACCEPT/REJECT indicator.

UNI MODE Two-position pushbutton switch selects either semi-gaussian or triangular pulse shaping for the unipolar (UNI) output.

MULTIPLIER (X1-X2) Pushbutton switch extends the basic range of PEAKING TIMES by a factor of two.

POLE-ZERO (P/Z)

COARSE Multi-turn screwdriver adjustable control for cancellation of preamplifier decay times from 40 μsec to infinity.

FINE Multi-turn screwdriver adjustable control for precision cancellation of preamplifier decay times. The FINE control allows a 10% variation of the COARSE P/Z adjustment.

PEAKING TIME Six-position rotary switch selects gaussian unipolar peaking times of 0.5, 0.75, 2, 3, 8 and 12 μsec. A dual pointer knob indicates approximate equivalent SHAPING TIMES of 0.25, 0.375, 1, 1.5, 4 and 6 μsec. A X1-X2 MULTIPLIER doubles the range of gaussian peaking times. The triangular peaking time equals 1.20 times the selected gaussian peaking time, while the bipolar peaking time equals 0.75 times the selected gaussian peaking time.

POLARITY POS - NEG Two position toggle switch selects either positive or negative polarity preamplifier signals for the amplifier input.

P/Z Momentary contact pushbutton switch inserts a diode limiter in series with front-panel UNI connector and test point. Allows oscilloscope sensitivity to be increased without overload of the oscilloscope front end for accurate P/Z adjustment.

BASELINE RESTORER (BLR)

HIGH-P/Z-AUTO Three-position toggle switch selects BLR restoration (slew) rate. The HIGH position provides a fixed high slew rate, while the AUTO position continuously adjusts the slew rate as a function of input count rate for optimum performance. The P/Z position disables the BLR for accurate pole-zero cancellation adjustment.

SYM-ASYM Two-position toggle switch selects SYMmetrical or ASYMmetrical operation of the baseline restorer. ASYMmetrical operation provides a restoring current of three times the charging current to the BLR memory capacitor.

SINGLE ENDED - DIFFERENTIAL Rear-panel two-position locking toggle switch selects SINGLE ENDED inputs from front- and rear-panel SIGNAL IN connectors, or DIFFERENTIAL input through the rear-panel preamplifier connector.

INPUTS

SIGNAL Front- and rear-panel BNC type connectors or rear-panel preamplifier connector accept either positive or negative signals with risetimes less than the selected peaking time and decay times of 40 μsec to infinity. The input impedance in the POS switch position is 500 ohms for COARSE GAIN settings of 10 or greater and 1050 ohms for COARSE GAIN setting of 5. The input impedance in the NEG switch position is 1500 ohms for COARSE GAIN settings of 10 or greater and 2050 ohms for COARSE GAIN setting of 5. The input is dc-coupled and protected to $\pm$25 volts maximum.

TEST Front- and rear-panel BNC type connectors accept test pulse inputs which are routed to TENNELEC preamplifiers through the preamplifier power cable.

ADC BUSY Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which indicate the ADC is available to process an event. Lost events are statistically corrected by extending live time. Internally selectable as active low or active high logic.

INHIBIT Rear-panel BNC type connector accepts either positive NIM-standard logic or TTL levels which disables the pileup rejector operation. Internally selectable as active low or active high logic.

OUTPUTS

UNI Front- and rear-panel BNC type connectors provide positive unipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Selectable output impedance of either $<$1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs are dc-restored to 0 $\pm$5 mV and short-circuit protected. A front-panel UNI indicator illuminates whenever an event (pulse) exceeds the unipolar BLR gate threshold.

BI Front- and rear-panel BNC type connectors provide positive lobe leading bipolar shaped pulses with a full-scale linear range of 10 volts (11.5 volts maximum). Selectable output impedance of either $<$1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0 $\pm$10 mV and are short-circuit protected.

PUR Front- and rear-panel BNC type connectors provide a positive linear output whose amplitude equals the peak of the unipolar output. The PUR output pulses are near rectangular shape with a 0.4 μsec rise/fall time and a 50% amplitude-width of 1.5 μsec. Selectable output impedance of either $<$1 ohm or 50 ohms for both front- and rear-panel output connectors. Outputs have a dc-level of 0 $\pm$5 mV and are short-circuit protected.

DELAY When the unipolar delay option board is installed, the rear-panel BNC type connector provides a unipolar output which is delayed 2 μsec from the simultaneous prompt unipolar output. Selectable output impedance of either $<$1 ohm or 50 ohms. Output has a dc-level of 0 $\pm$10 mV and is short-circuit protected.

ICR Rear-panel BNC type connector provides a 250 nsec wide positive NIM-standard logic pulse for each event which exceeds the pileup inspector threshold. Output impedance is 50 ohms, dc-coupled.

DT Rear-panel BNC type connector provides a logic signal to the ADC clock which provides statistical live time correction for the amplifier, pileup rejector and ADC by extending live time. Also functions with external Loss Free Counting (LFC) module to statistically correct for counting losses in real time. Positive NIM-standard logic output is internally selectable as active low or active high. Output impedance is 50 ohms, dc-coupled.

PREAMP Rear-panel 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC or other commercially available preamplifiers.

ORDERING INFORMATION

POWER REQUIREMENTS (excluding preamplifier)
+24 V, 125 mA; +12 V, 450 mA
-24 V, 250 mA; -12 V, 200 mA

WEIGHT (SHIPPING) 8.0 lbs. (3.6 kg)
(NET) 5.0 lbs. (2.3 kg)

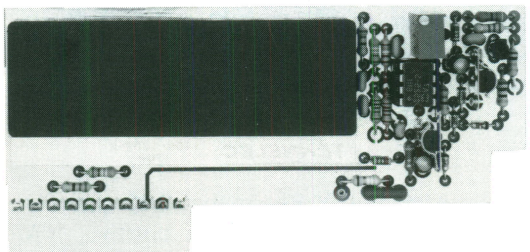
DIMENSIONS Standard double-width NIM module (2.70 x 8.714 in.) per TID-20893 (Rev).

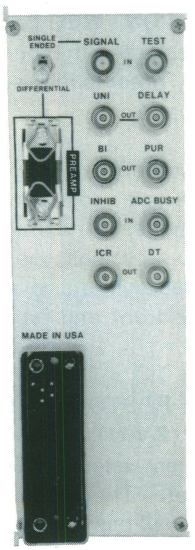
INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 preamp power adapter to be used with earlier TENNELEC preamplifiers (S/N $<$2000).

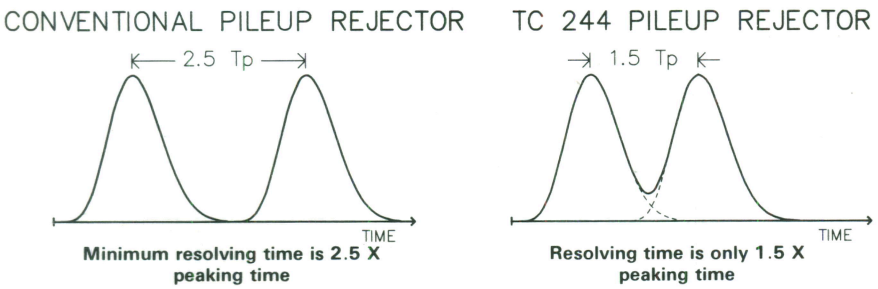
TC 244 Amplifier

OPTION The TC 244 may be ordered with a TC 244-02 option which provides a rear-panel delayed unipolar output that occurs 2 μsec after the simultaneous prompt unipolar output. This option is field-installable by the customer.





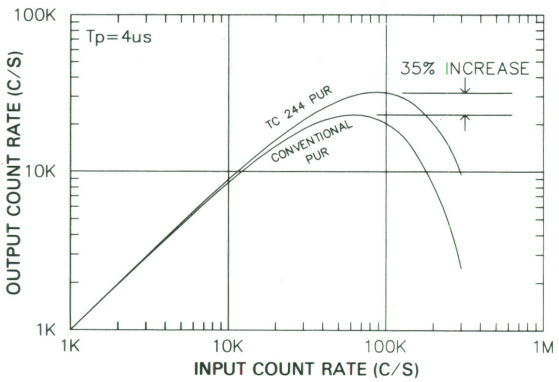
(Rear View)



TC 244 Improved Pulse Resolving Time

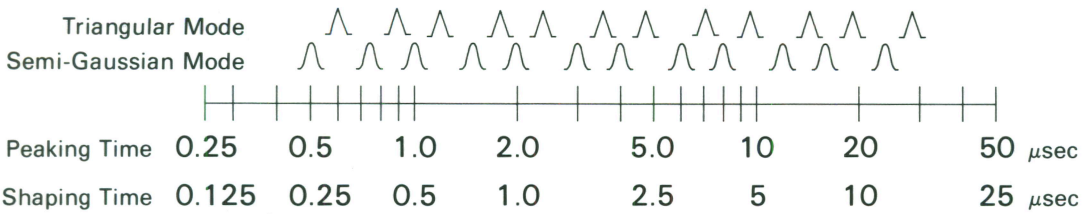
In a conventional amplifier with pulse pileup rejection, the minimum resolving time is limited to 2.5 times the peaking time. The trailing edge of the first pulse must return to the baseline before a second pulse begins; otherwise the second pulse will be rejected. This results in an excessive number of pulses being rejected and increases sample counting times.

The resolving time of the new TENNELEC TC 244 pileup rejector is only 1.5 times the peaking time. This means that if the peak of the second pulse occurs after the tail of the preceeding pulse would have returned to the baseline, then the second pulse will be accepted as a valid pulse. In the case of the TC 244, pulses may occur as close together as 1.5 times the peaking time selected and still be processed as valid pulses.



TC 244 Higher Throughput / Count Rate Capability

Because the TENNELEC TC 244 does not throw away as many pulses as conventional units, a dramatic improvement in throughput/count rate capability occurs. With a resolving time of 1.5 times the peaking time the TC 244 offers up to 35% increase in count rate capability.



TC 244 Twenty-Four (24) Time Constants for Optimum Resolution

Triangular and semi-gaussian pulse shaping allows selection of the best time constant to minimize parallel (step) and series (delta) noise.

TENNELEC INC.

TENNELEC, Inc., 601 Turnpike, P.O. Box 2560, Oak Ridge, Tennessee 37831-2560, USA.

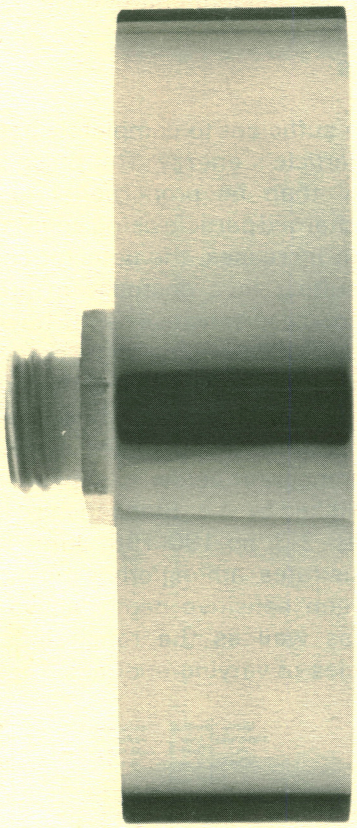
PHONE 615-483-8405 TWX 810-572-1018

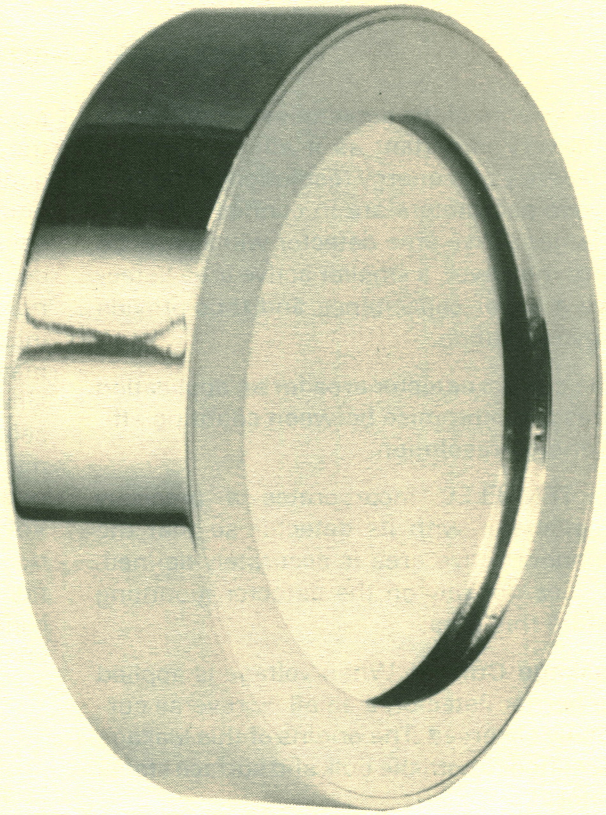
TC 244 10.0K 1185

TENNELEC

Silicon Charged Particle Detectors

Domestic Selection Guide and Price List September 1986





- **Built in collimator defines active area - no epoxy halo, nominal area is all active**
- **Detector-to-mount spacings of ≤1 mm for better geometry**
- **Ultra low background "see-no-alpha" detectors available**
- **Backed up by state of the art electronics: preamplifiers, amplifiers, bias supplies and constant fraction discriminators**

TENNELEC **Silicon Charged Particle Detectors** are available in several active areas from 25 mm^2 to 2000 mm^2, sensitive depths from 40 microns to greater than 1000 microns and in extremely compact, Slimline™ housings to provide the research and industrial spectroscopist with the correct detector for nearly any application.

TENNELEC's comprehensive line of detectors consists of eight (8) series.

- **PD Series** — Partially Depleted
- **PP Series** — Premium Partially Depleted
- **CE Series** — Cleanable Front Electrode
- **TD Series** — Transmission Detector
- **TP Series** — Transmission Planar
- **HI Series** — Heavy Ion
- **HE Series** — Harmful Environment
- **CAM Series** — Continuous Air Monitor

Introduction

TENNELEC Silicon Charged Particle Detectors are surface barrier detectors made of high quality, single crystal silicon utilizing state-of-the-art technology.

Surface barrier detectors for charged particle spectroscopy have wide application in physics and nuclear chemistry. They can be used to detect and analyze charged particles over a broad range of energies with essentially 100% efficiency for their active volume.

A detector's active volume is created by an electric field applied across the detector's contacts. This electric field sweeps the region between the detector contacts free of charge carriers. Incoming charged particles enter this charge-free region through a thin, insensitive window of gold or aluminum. Through electromagnetic and electrostatic (Coulomb) interaction, the charged particle's energy is transferred to the detector, creating electron-hole pairs. These electron-hole pairs are then swept clear of the depleted, sensitive region and collected on the oppositely-charged electrodes (detector contacts). The integrated charge collected is proportional to the energy lost by the incident charged particle.

Operational Characteristics

Area The active area of the detector selected for any application is very important as it affects both the counting efficiency and energy resolution of the system. These two parameters are in conflict with one another. A larger active area detector will always be more efficient, however, a smaller active area detector will have a lower capacitance and thus provide better energy resolution.

Selecting the correct detector area for an application often requires a compromise between counting efficiency and energy resolution.

Collimation TENNELEC incorporates a precisely machined collimator with its detector so that the entrance window active area is accurately defined. TENNELEC does not rely on the detector mounting epoxy to define this area.

Reverse Leakage Current When voltage is applied to a surface barrier detector, a small dc reverse current is normally observed. The origins of this leakage current are related to both the bulk and surface states of the detector.

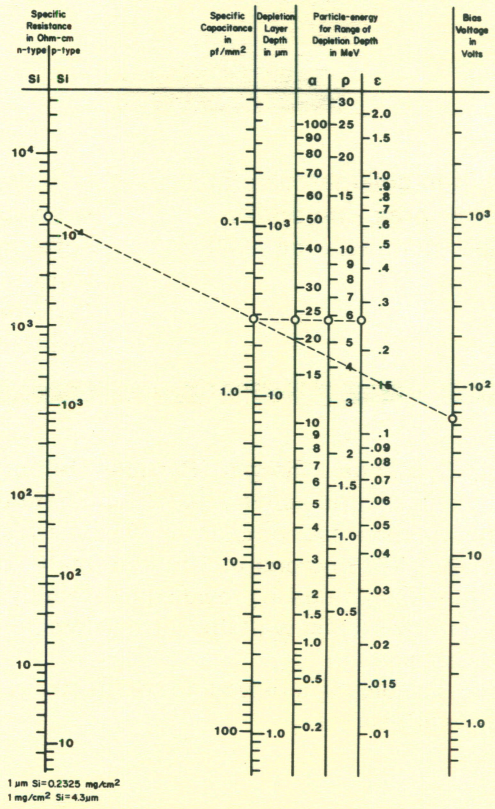
This reverse leakage current increases the detector noise and thus degrades the system energy resolution. Each and every detector supplied by TENNELEC is subjected to stringent quality assurance procedures to assure that no detector has an excessive leakage current.

Bias Voltage Compensation The bias voltage to the detector is always supplied through a series resistor found in the preamplifier for signal isolation. There is a voltage drop across this resistor equal to the product of the leakage current and the series resistor. The bias voltage must be modified upwards to compensate for this drop.

$$V_d = V_a - (I_l \times R_s)$$

V_d = True detector voltage
V_a = Voltage applied
I_l = Detector leakage current
R_s = Preamplifier bias resistor.

Sensitive Depth For charged particle spectroscopy and most other applications, the detector's sensitive depth must be sufficient to completely absorb all of the incident particle's energy. The pulse amplitude generated will then be proportional to the total energy of the charged particle being analyzed. As this sensitive depth increases, the detector capacitance decreases resulting in a decrease in preamplifier noise. This increase in sensitive depth, however, also increases the sensitive volume of the detector which may increase the detectors noise contribution. Sensitive depth, like active area, must be carefully selected to optimize the detector system performance. The nomogram below is similar to the one originally published by J. L. Blankenship, IRE Trans. Vol. NS-7, Nos. 2-3, pp 190-195, June 1960. This nomogram illustrates, among other things, the relationship between sensitive depth, active area and capacitance, as well as the range in silicon for charged particles of varying energies.



Capacitance The major effect of detector capacitance on system performance is its influence on the noise generated by the preamplifier. Additionally, detector capacitance affects the rise time of the preamplifier. Two ways to minimize detector capacitance are to restrict the active area and/or to increase the sensitive depth. In general, a factor of 10 increase in sensitive depth will result in a 10 fold decrease in capacitance in picofarads per mm^2 of active area. For example: 100 μ deep has 1 pf/mm^2; 1000 μ deep has 0.1 pf/mm^2.

Noise and Energy Resolution† There are three major sources of noise in a silicon surface barrier detector.

1. Bulk leakage current
2. Surface leakage current
3. Johnson noise

These noise sources result in spectral peak broadening and therefore a degradation of resolution. These noise sources add in quadrature, so that;

$$(\Delta E_{noise})^2 = (\Delta E_{bulk})^2 + (\Delta E_{surface})^2 + (\Delta E_{Johnson})^2$$

where ΔE represents the peak broadening due to each noise source.

Entrance Window Thickness A charged particle entering a detector must pass through an insensitive region, entrance window, before reaching the active volume of the detector. In passing through this window, an amount of energy will be lost as a function of particle size, energy, window thickness and angle of incidence. As this lost energy is a contributor to detector resolution degradation, the entrance window must be as thin as possible and yet thick enough so as not to compromise good electrical contact.

The entrance window for the TENNELEC PD, PP, TD, TP and HI Series detector is $\leq$40 μgms/cm^2 gold, which is nominally equivalent to 800 angstroms of silicon. Total dead layer does not exceed 20 keV energy loss for 5.486 MeV alpha particles. The exit window of the TD and TP Series detectors is $\leq$40 μgms/cm^2 aluminum, which is nominally equivalent to 2250 angstroms of silicon. The entrance window of the CE Series is $\leq$50 μgms/cm^2 aluminum, which is nominally equivalent to 2300 angstroms of silicon. Contact TENNELEC for light tight or other special entrance window requirements.

CAM-500 and HE Series detectors are usually operated in the counting mode. Entrance window thickness is of minimal concern for this mode of use. Maximum energy loss through these windows is <120 keV for 5.486 MeV alpha particles.

The TENNELEC Detector

TENNELEC offers a complete line of Slimline™ detectors featuring low background, increased area, improved geometry, improved resolution and superior timing performance.

Low Background All TENNELEC detectors are specially manufactured and packaged to minimize background problems. TENNELEC accomplishes this through the use of smaller mounting components and using materials which have virtually no naturally occurring radionuclide contaminates.

Increased Area The Slimline™ package does not rob active area from the silicon wafer.

Improved Geometry The Slimline™ design places the detector front electrode less than 1 mm from the front surface of the housing (less than 0.5 mm for unmounted detectors). This means that oblique entry angles are essentially unshadowed by the external package. The housings are thinner than other detectors. This allows larger detectors to be placed into smaller counting chambers and transmission mount detectors can be stacked more closely together.

Improved Resolution Because of our new MIS technology, the Slimline™ detector has lower noise and better energy resolution. This MIS technology reduces the thickness of the silicon oxide layer which reduces the noise and improves the energy resolution.

Superior Timing The Slimline™ detector mount uses no coil springs. Thus, a major inductive component is eliminated from the signal path and thus improves risetime performance to further enhance timing performance.

Detector Description

Partially Depleted (PD) Series detectors are available in a wide range of active areas from 25 mm^2 to 1000 mm^2, and sensitive depths from 100 microns to 1000 microns. (See Table 1). Other sensitive depths and areas are available on special request.

Premium Partially Depleted (PP) Series detectors are the best of the best PD Series detectors and are available in a wide range of active areas from 25 mm^2 to 500 mm^2 and sensitive depths from 100 microns to 500 microns. See Table 2 for a complete selection of available detectors.

Cleanable Front Electrode (CE) Series detectors have a rugged, cleanable aluminum entrance window. These detectors are available in several active areas from 50 mm^2 to 2000 mm^2 and sensitive depths from 100 microns to 1000 microns (See Table 3). Other areas and depletion depths are available on special request.

† From Glenn F. Knoll, "Radiation Detection and Measurement", John Wiley & Sons, New York, 1979, Chapter 11.

Transmission Detector (TD) Series spectrometers are sensitive through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are typically used in ΔE and timing experiments and are offered in a variety of active areas and thicknesses, from 25 mm^2 to 500 mm^2 and 150 microns to 1000 microns (See Table 4). Other thicknesses and areas are available on special request.

All TD Series detectors are cut off-axis from the original crystal to minimize particle channeling. Specified alpha resolutions for detectors <500 microns thick are for 5.486 MeV alpha particles incident through the rear (low field) electrode.

Transmission Planar (TP) Series detectors are totally depleted through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are specially processed for the ultimate in planarity and thickness uniformity across the entire active area. Detectors are available in thicknesses from 40 microns to 100 microns and active areas from 25 mm^2 to 300 mm^2 (See Table 5). Other thicknesses and areas available on special request.

Heavy Ion (HI) Series detectors are partially depleted to a sensitive depth of ≥60 microns and manufactured from silicon with characteristics that withstand extremely high electric field strengths (≥15,000 volts/cm at the entrance window) without introducing surface multiplication effects. Active areas from 100 mm^2 to 1000 mm^2 are available (See Table 6) with other areas available on special request. All HI series detectors are cut off-axis to minimize channeling and come in a close mount (<0.040") configuration. Second category devices with a slightly lower field strength are offered.

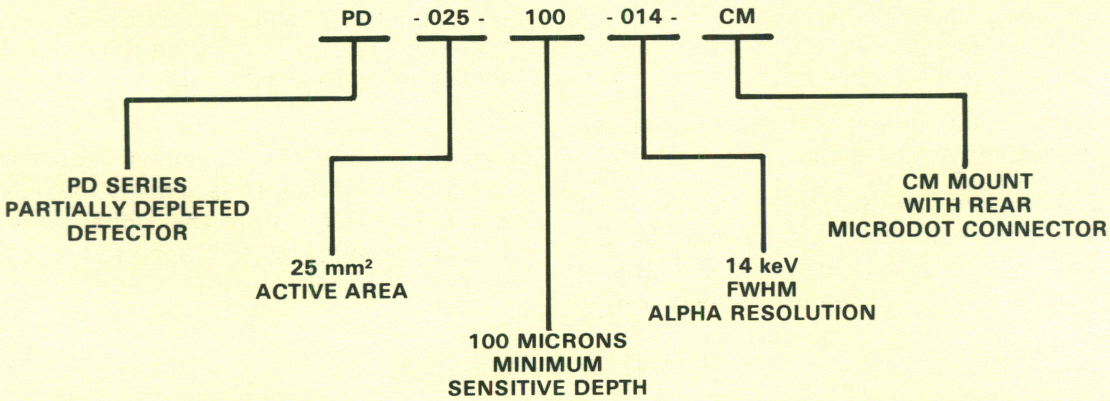
CAM 500 Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors (CAMs). These detectors are resistant to ambient light and cleanable. CAM 500 Series detectors have a 500 mm^2 nominal active area and come in two standard models configured for your mounting needs, the CAM 500B with a rear-mounted female BNC connector and the CAM 500M with a rear-mounted female microdot connector (See Table 7). Other configurations can be supplied on special request.

Harmful Environment (HE) Series alpha detectors are specifically designed and produced to operate in commercially available Continuous Air Monitors under harmful corrosive gas conditions. The HE 500 Series detectors are configured in the same manner as the CAM 500 Series detectors. In addition, the HE 500 Series are specially treated with a corrosion-resistant polymer coating over the front gold electrode. This dramatically extends the useable lifetime of this detector under corrosive gas conditions, such as hydrofluoric acid. (See Table 8). Other configurations can be supplied on special request.

General Information

Model Number

The TENNELEC model number fully defines the physical and performance specifications of the detector.



Alpha Resolution is warranted as the full peak width at one-half the maximum peak height (Full Width at Half Maximum, FWHM) expressed in keV for Americium - 241, 5.486 MeV alphas. The actual measured resolution will be better than the warranted resolution. Specifications are based on measurements made with standard TENNELEC electronics and an electroplated alpha source and include the electronic noise contribution of the preamplifier.

Beta Resolution is approximately the noise width measured at the FWHM expressed in keV for an electronic pulser peak. Measurements are made with standard TENNELEC electronics and include the electronic noise contribution of the preamplifier.

Collimation Slimline™ detectors are designed so that special collimators can be located to within 1 mm (0.040") of the detector entrance window. Internally mounted collimators can be located to within 0.5 mm (0.020") of the entrance window. For more information on collimators, contact the factory.

Mount Types

TENNELEC Silicon charged particle detectors are available in five (5) standard mount types.

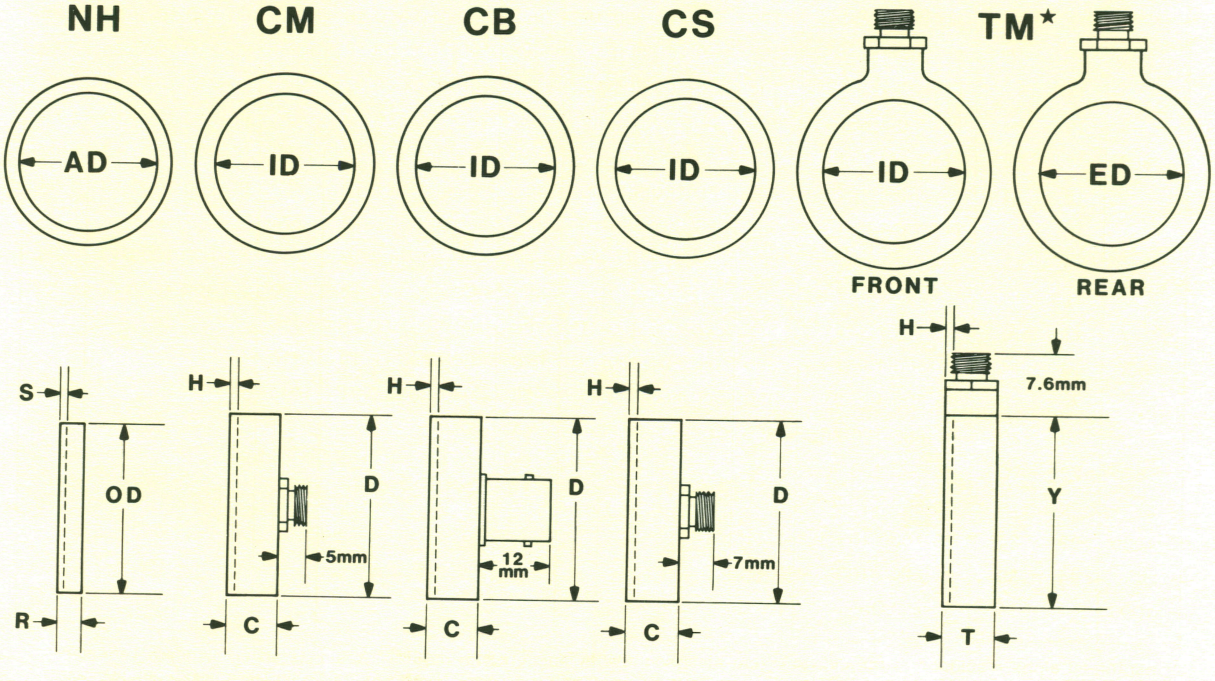
Mount Type	Description
CB	Rear BNC connector
CM	Rear Microdot connector
CS	Rear SMA connector
NH	No housing
TM	Transmission, side microdot connector
TS	Transmission, side SMA connector

mount types are available on special request.

Specifications and Definitions Standards

All TENNELEC specifications and definitions of terms comply with the latest revisions of IEEE/ANSI 300 and IEC 333. Warranted performance is for operation in vacuum at 20°C at the amplifier peaking time (T_p) shown. For modern, high performance amplifiers, T_p is approximately two (2) times the shaping time constant.

Mount Dimensions



Active Area (mm^2)	Active Diameter A.D.±0.2 I.D.†± 0.0 0.2 mm	Exit Opening E.D.±0.1 mm	Outside Diameter ±0.3 mm		
			OD	D	Y
25	5.6	6.9	12.7	16.6	15.1
50	8.0	9.3	14.6	16.6	18.3
100	11.3	12.6	18.4	23.0	20.8
150	13.8	15.1	20.9	23.0	24.9
200	16.0	17.6	23.0	28.4	25.0
300	19.6	20.8	26.2	28.4	28.5
400	22.6	23.8	29.6	32.0	32.0
500	25.3	26.5	32.2	34.3	34.7
600	27.6	28.9	34.1	36.0	37.3
1000	35.7	37.0	43.1	45.2	47.0
2000	50.5	—	59.6	60.9	—

Active Depth (μm)	Front Surface To Det. Spacing ±0.1 mm		Detector Thickness ±0.3 mm		
	S	H	R	C	T
0-600	0.5	1.0	1.5	9.0	7.6
601-1100	1.0	1.6	3.0	12.6	10.0
1200-2100	1.3	1.9	4.6	12.6	12.6

★ SMA connector on transmission type housing available on special order.

† I.D. is provided through a built-in collimator only found with TENNELEC charged particle detectors. This removes the epoxy halo effect and gives you a precise active area.

Table 1. PD Series Partially Depleted Detectors

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth						Min Sensitive Depth	
			100 μm		300 μm		500 μm		1000 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	13	6	PD-25-100-13	170	PD-25-300-13	370	PD-25-500-13	670	PD-25-1000-13	1150
	14	6	PD-25-100-14	135	PD-25-300-14	280	PD-25-500-14	510	PD-25-1000-14	880
	15	7			PD-25-300-15	195	PD-25-500-15	405	PD-25-1000-15	675
50	14	7	PD-50-100-14	195	PD-50-300-14	380	PD-50-500-14	720	PD-50-1000-14	1200
	15	8	PD-50-100-15	170	PD-50-300-15	290	PD-50-500-15	550	PD-50-1000-15	930
	17	9	PD-50-100-17	145	PD-50-300-17	245	PD-50-500-17	445	PD-50-1000-17	775
100	14	7	PD-100-100-14	300	PD-100-300-14	570	PD-100-500-14	930	PD-100-1000-14	1420
	15	8	PD-100-100-15	265	PD-100-300-15	470	PD-100-500-15	770	PD-100-1000-15	1300
	16	9	PD-100-100-16	205	PD-100-300-16	365	PD-100-500-16	585	PD-100-1000-16	905
150	15	9	PD-150-100-15	330	PD-150-300-15	610	PD-150-500-15	970	PD-150-1000-15	1580
	16	10	PD-150-100-16	285	PD-150-300-16	490	PD-150-500-16	780	PD-150-1000-16	1340
	18	12	PD-150-100-18	225	PD-150-300-18	355	PD-150-500-18	625	PD-150-1000-18	1265
200	16	10	PD-200-100-16	400	PD-200-300-16	730	PD-200-500-16	1060	PD-200-1000-16	1690
	17	11	PD-200-100-17	345	PD-200-300-17	540	PD-200-500-17	860	PD-200-1000-17	1570
	19	14	PD-200-100-19	290	PD-200-300-19	395	PD-200-500-19	685	PD-200-1000-19	1475
300	17	13	PD-300-100-17	490	PD-300-300-17	800	PD-300-500-17	1180	PD-300-1000-17	1850
	18	14	PD-300-100-18	425	PD-300-300-18	660	PD-300-500-18	960	PD-300-1000-18	1740
	19	15	PD-300-100-19	335	PD-300-300-19	465	PD-300-500-19	775		
400	18	13	PD-400-100-18	540	PD-400-300-18	840	PD-400-500-18	1210	PD-400-1000-18	2390
	19	14	PD-400-100-19	440	PD-400-300-19	690	PD-400-500-19	990	PD-400-1000-19	2030
	21	16	PD-400-100-21	350	PD-400-300-21	480	PD-400-500-21	795		
500	19	14	PD-500-100-19	590	PD-500-300-19	880	PD-500-500-19	1310		
	21	16	PD-500-100-21	450	PD-500-300-21	695	PD-500-500-21	1040		
	25	20	PD-500-100-25	355	PD-500-300-25	485				
600	22	18	PD-600-100-22	950						
	24	19	PD-600-100-24	565						
1000	39	34	PD-1000-100-39	1205						
	44	39	PD-1000-100-44	955						
>1000			Special Order							

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

Performance guaranteed for one (1) year.

PD Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 3. PP Series Premium Partially Depleted Detectors

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	12	5	PP-25-100-12	405	PP-25-300-12	555	PP-25-500-12	775
50	13	6	PP-50-100-13	465	PP-50-300-13	655	PP-50-500-13	1005
100	13	6	PP-100-100-13	605	PP-100-300-13	855	PP-100-500-13	1155
150	14	8	PP-150-100-14	715	PP-150-300-14	985	PP-150-500-14	1215
200	15	9	PP-200-100-15	745	PP-200-300-15	1085	PP-200-500-15	1345
300	16	12	PP-300-100-16	885	PP-300-300-16	1205	PP-300-500-16	1455
400	17	12	PP-400-100-17	985	PP-400-300-17	1315	PP-400-500-17	1555
500	18	13	PP-500-100-18	1085	PP-500-300-18	1435	PP-500-500-18	1655

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

Premium performance guaranteed for 3 months. Best category PD Series performance for equivalent size detector guaranteed for remaining 9 months of one (1) year guarantee.

PP Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 2. CE Series Cleanable Front Electrode Detectors.

Active Area (mm²)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 100 μm		Minimum Sensitive Depth 300 μm		Minimum Sensitive Depth 500 μm		Guaranteed Max Resolution (keV)[1]		Minimum-Sensitive Depth 1000 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	α	β	Model No.	Price
50	15	7	CE-50-100-15	405	CE-50-300-15	655	CE-50-500-15	995	17	10	CE-50-1000-17	1725
	17	8	CE-50-100-17	325	CE-50-300-17	475	CE-50-500-17	915				
100	16	10	CE-100-100-16	445	CE-100-300-16	665	CE-100-500-16	1090	19	12	CE-100-1000-19	1870
	18	11	CE-100-100-18	365	CE-100-300-18	550	CE-100-500-18	1005				
150	16	10	CE-150-100-16	495	CE-150-300-16	675	CE-150-500-16	1185	20	13	CE-150-1000-20	2015
	19	11	CE-150-100-19	405	CE-150-300-19	625	CE-150-500-19	1095				
300	19	13	CE-300-100-19	825	CE-300-300-19	965	CE-300-500-19	1415	22	17	CE-300-1000-22	2305
	21	15	CE-300-100-21	645	CE-300-300-21	795	CE-300-500-21	1295				
400	22	17	CE-400-100-22	870	CE-400-300-22	1100	CE-400-500-22	1515	25	19	CE-400-1000-25	2475
	24	19	CE-400-100-24	690	CE-400-300-24	895	CE-400-500-24	1365				
500	23	18	CE-500-100-23	915	CE-500-300-23	1255	CE-500-500-23	1615	26	20	CE-500-1000-26	2625
	26	20	CE-500-100-26	740	CE-500-300-26	990	CE-500-500-26	1435				
600	25	19	CE-600-100-25	1165	CE-600-300-25	1455	CE-600-500-25	2235	34	30	CE-600-1000-34	Special Order
	33	28	CE-600-100-33	995	CE-600-300-33	1435	CE-600-500-33	1965				
1000	33	28	CE-1000-100-33	1550	CE-1000-300-33	2095	CE-1000-500-33	3235				
	40	35	CE-1000-100-40	1430	CE-1000-300-40	1955	CE-1000-500-40	3025				
2000	50	40	CE-2000-100-50	2595	CE-2000-300-50	3235	CE-2000-500-50	3810				
	60	55	CE-2000-100-60	2395	CE-2000-300-60	3030	CE-2000-500-60	3575				

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

Performance guaranteed for one (1) year.

CE Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

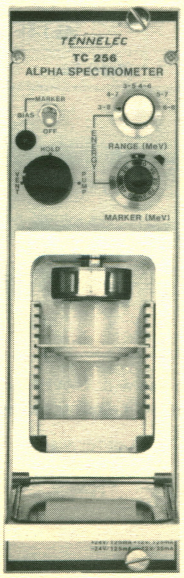
Complete Alpha Spectroscopy Modules

- **Self contained**
- **Low background**
- **Large sample chamber**
- **Vacuum hold**
- **Adjustable bias voltage**
- **Variable calibrated pulser**
- **Front panel selectable energy ranges**
- **Easily adjustable for 0-8V or 0-10V ADC's**

TENNELEC produces two complete alpha spectrometers packaged in a double-width NIM module, the TC 256, and a triple-width NIM module, the TC 257. These units contain a vacuum chamber, charge sensitive preamplifier, linear amplifier, discriminator, biased amplifier, variable high voltage supply and adjustable test pulser and are specifically designed for operation with silicon surface barrier detectors.

TC 256 and TC 257 units are available as pretested, calibrated systems with your choice of PD or CE series detector. Specially selected ultra low background "see-no-alpha" (SNA) detectors are available on request.

If you have samples of 1.75 inch diameter or less, the TC 256 is recommended. Should your samples be larger than 1.75 inches, the TC 257 is recommended. The TC 257 will accommodate samples up to 2.25 inches in diameter and accepts the stainless steel sample carriers that are used in TENNELEC's Low Background Alpha/Beta/Gamma counting systems. Also see individual NIM based alpha spectroscopy systems on page 11.



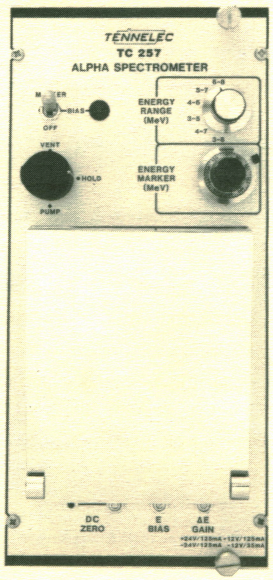


Table 4. TD Series Transmission Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)							
			150 μm (125-175 μm)		200 μm (176-225 μm)		250 μm (226-275 μm)		300 μm (276-350 μm)	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	15	6	TD-25-150-15	335	TD-25-200-15	355	TD-25-250-15	375	TD-25-300-15	395
	16	7	TD-25-150-16	265	TD-25-200-16	285	TD-25-250-16	305	TD-25-300-16	325
50	15	6	TD-50-150-15	485	TD-50-200-15	505	TD-50-250-15	525	TD-50-300-15	545
	16	7	TD-50-150-16	375	TD-50-200-16	395	TD-50-250-16	415	TD-50-300-16	435
100	16	8	TD-100-150-16	585	TD-100-200-16	615	TD-100-250-16	645	TD-100-300-16	685
	17	9	TD-100-150-17	465	TD-100-200-17	495	TD-100-250-17	515	TD-100-300-17	545
150	17	9	TD-150-150-17	625	TD-150-200-17	675	TD-150-250-17	705	TD-150-300-17	795
	18	10	TD-150-150-18	495	TD-150-200-18	555	TD-150-250-18	575	TD-150-300-18	635
200	18	10	TD-200-150-18	665	TD-200-200-18	705	TD-200-250-18	745	TD-200-300-18	855
	19	13	TD-200-150-19	545	TD-200-200-19	585	TD-200-250-19	615	TD-200-300-19	695
300	19	12	TD-300-150-19	745	TD-300-200-19	795	TD-300-250-19	875	TD-300-300-19	935
	20	15	TD-300-150-20	645	TD-300-200-20	685	TD-300-250-20	715	TD-300-300-20	725
400	23	17	TD-400-150-23	810	TD-400-200-23	865	TD-400-250-23	920	TD-400-300-23	965
	24	19	TD-400-150-24	675	TD-400-200-24	715	TD-400-250-24	745	TD-400-300-24	755
500	24	18	TD-500-150-24	875	TD-500-200-24	935	TD-500-250-24	965	TD-500-300-24	995
	25	20	TD-500-150-25	705	TD-500-200-25	745	TD-500-250-25	775	TD-500-300-25	785

[1]Guaranteed alpha resolution is through the rear electrode for thickness ≤500 μm and through the front electrode for thicknesses >500 μm, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time). Beta resolution approximated by pulser width FWHM.

Performance guaranteed for one (1) year.

TD Series detectors supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 5. TP Series Transmission Planar Detectors

Active Area (mm^2)	Maximum Thickness Variation (Microns)	Depletion Depth (Range)							
		40 μm (35.1-45 μm)		50 μm (45.1-65 μm)		75 μm (65.1-85 μm)		100 μm (85.1-110 μm)	
		Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	±0.5	TP-25-40-15	815	TP-25-50-15	690	TP-25-75-15	655	TP-25-100-15	575
50	±0.5	TP-50-40-20	1090	TP-50-50-15	950	TP-50-75-15	835	TP-50-100-15	745
100	±1.0	TP-100-40-25	1295	TP-100-50-25	1080	TP-100-75-20	975	TP-100-100-20	885
150	±1.0	TP-150-40-35	1420	TP-150-50-30	1180	TP-150-75-30	1065	TP-150-100-25	945
200	±1.0	TP-200-40-40	1595	TP-200-50-35	1390	TP-200-75-35	1145	TP-200-100-25	1015
300	±1.0	TP-300-40-50	1910	TP-300-50-45	1540	TP-300-75-40	1335	TP-300-100-30	1245

[1]Last two (2) digits of model number indicate total system noise width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time), for the thinnest detector (highest capacitance) in each thickness range.

TP Series detectors are supplied in TM mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Continued

Depletion Depth (Range) 400 μm (351-450 μm)		Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range) 500 μm (451-550 μm)		700 μm (650-750 μm)		1000 μm (950-1050 μm)	
Model No.	Price	α	β	Model No.	Price	Model No.	Price	Model No.	Price
TD-25-400-15	615	15	7	TD-25-500-15	815	TD-25-700-15	1385	TD-25-1000-15	1685
TD-25-400-16	465	16	8	TD-25-500-16	615	TD-25-700-16	945	TD-25-1000-16	1225
TD-50-400-15	665	15	7	TD-50-500-15	1205	TD-50-700-15	1495	TD-50-1000-15	1785
TD-50-400-16	555	16	8	TD-50-500-16	875	TD-50-700-16	1075	TD-50-1000-16	1345
TD-100-400-16	835	16	9	TD-100-500-16	1235	TD-100-700-16	1625	TD-100-1000-16	1815
TD-100-400-17	675	17	10	TD-100-500-17	905	TD-100-700-17	1205	TD-100-1000-17	1475
TD-150-400-17	905	17	9	TD-150-500-17	1285	TD-150-700-17	1715	TD-150-1000-17	1885
TD-150-400-18	725	18	10	TD-150-500-18	945	TD-150-700-18	1275	TD-150-1000-18	1605
TD-200-400-18	995	18	10	TD-200-500-18	1375	TD-200-700-18	1815	TD-200-1000-18	1945
TD-200-400-19	785	19	13	TD-200-500-19	1035	TD-200-700-19	1375	TD-200-1000-19	1735
TD-300-400-19	1125	19	13	TD-300-500-19	1485	TD-300-700-19	1985	TD-300-1000-19	2075
TD-300-400-20	895	20	14	TD-300-500-20	1145	TD-300-700-20	1535	TD-300-1000-20	1925
TD-400-400-23	1175	20	15	TD-400-500-20	1575	TD-400-700-20	2025	Special Order	
TD-400-400-24	930	22	17	TD-400-500-22	1185	TD-400-700-22	1580		
TD-500-400-24	1225	21	16	TD-500-500-21	1665	TD-500-700-21	2065	Special Order	
TD-500-400-25	965	23	18	TD-500-500-23	1225	TD-500-700-23	1625		

Table 6. HI Series Heavy Ion Detectors

Active Area (mm^2)	Guaranteed Max Noise (keV)[1]	Minimum Sensitive Depth ≥60 μm: Field Strength ≥15 kV/cm		Field Strength ≥10 kV/cm	
		Model No.	Price	Model No.	Price
100	18	HI-100-60-18	395		
	28			HI-100-60-28	265
300	23	HI-300-60-23	525		
	33			HI-300-60-33	395
400	28	HI-400-60-28	765		
	38			HI-400-60-38	635
500	30	HI-500-60-30	1015		
	44			HI-500-60-44	895
600	33	HI-600-60-33	1375		
	50			HI-600-60-50	1235
1000	38	HI-1000-60-38	2095		
	55			HI-1000-60-55	1955

[1]Guaranteed max noise is approximated by pulser width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec (0.5 μsec shaping time).

[2]Active surface <1 mm from front of housing.

Performance guaranteed for six (6) months (does not include leakage current increases due to radiation damage)

HI Series detectors supplied in CM mount unless specified otherwise by the appropriate suffix.

Table 7.
CAM 500 Series Continuous Air Monitoring Alpha Detectors

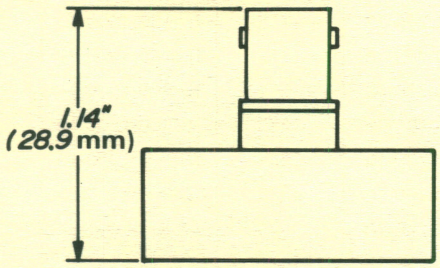
Area (mm^2)	Connector	Model No.	Price
500	BNC	CAM 500 B	295
500	Microdot	CAM 500 M	295

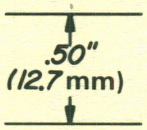
Table 8.
HE 500 Series Harmful Environment Alpha Detectors

Area (mm^2)	Connector	Model No.	Price
500	BNC	HE 500 B	495
500	Microdot	HE 500 M	495

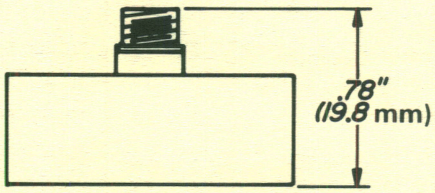
CAM 500 and HE 500 Mount Dimensions

CAM 500B or HE 500B

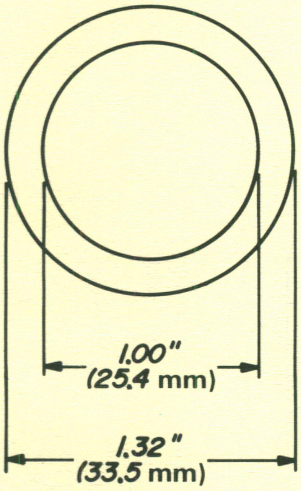




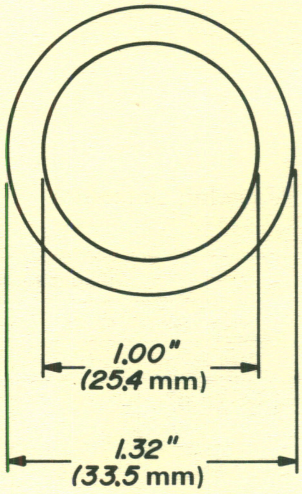
CAM 500M or HE 500M



BNC



93Ω Microdot



Price Schedule for Quantity Discounts			
CAM 500 Series		HE 500 Series	
Quantity	Price	Quantity	Price
1 to 9	295	1 to 9	495
10 to 24	265	10 to 24	465
25 to 99	245	25 to 99	435
100 to 199	225	100 to 199	410
200 to 399	210	200 to 399	390
400 and up	200	400 and up	370

Component Systems

With the use of TENNELEC's TV-1 Vacuum Chamber and selected electronic NIM modules a high quality Single Channel Alpha System can be configured. This can be a simple counting system with the use of a Single Channel Analyzer (SCA) and Counter and Timer or a Spectroscopy System with the use of a Multichannel Analyzer (MCA). By using a deeper detector, these systems can also be used for Beta detection. Also see alpha spectroscopy modules on page 7.

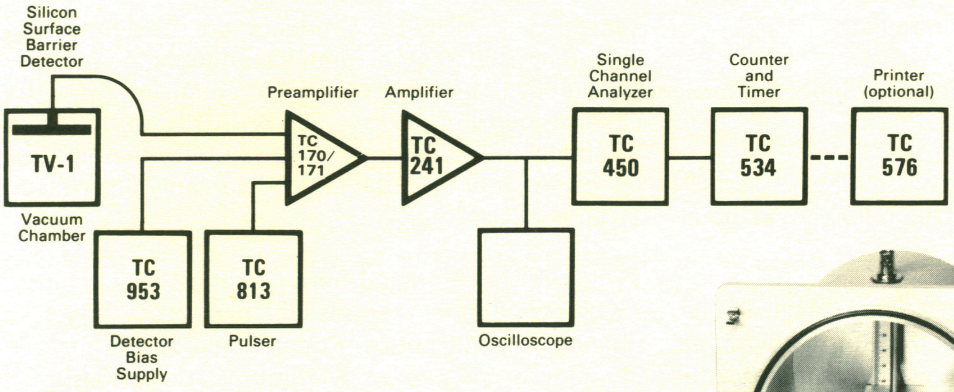
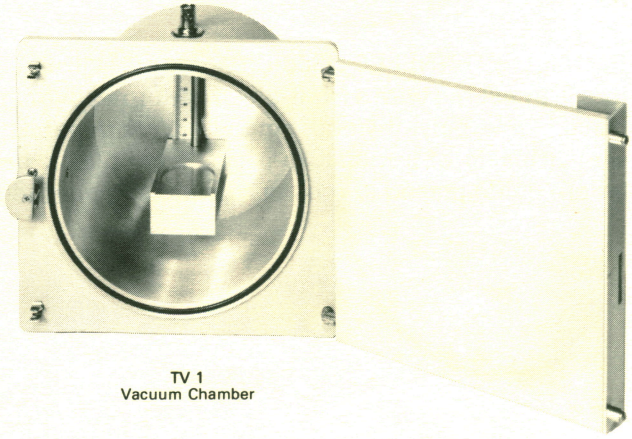


Figure 1
Single Channel Alpha Counting System



TV 1
Vacuum Chamber

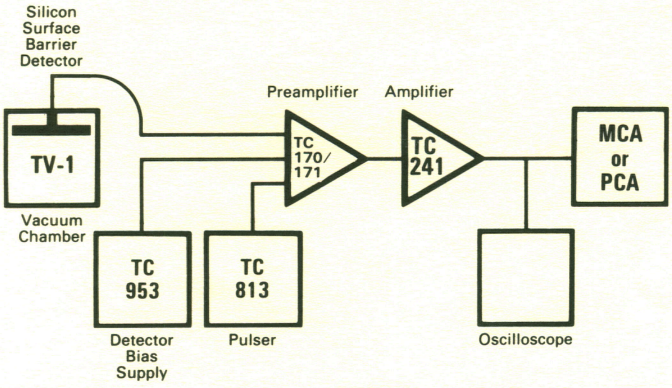
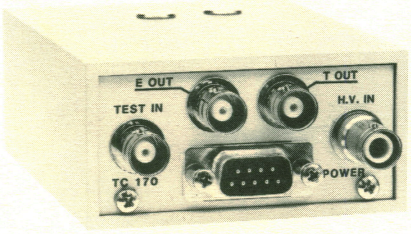
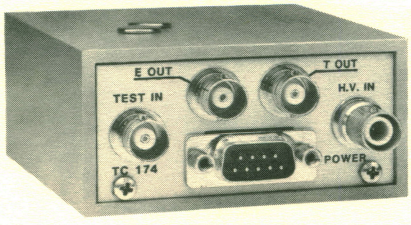


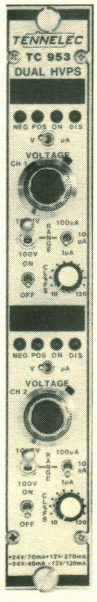
Figure 2
Alpha Spectroscopy System with Multichannel Analyzer (MCA)



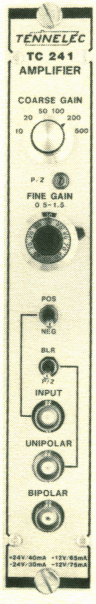
TC 170/TC 171
Spectroscopy Preamplifiers



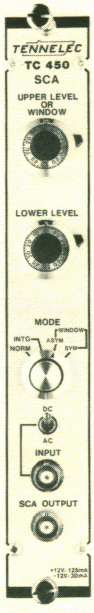
TC 174 General Purpose Preamplifier



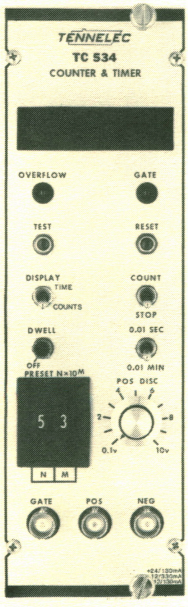
TC 953 HV Bias Supply



TC 241 Spectroscopy Amplifier



TC 450 Single-Channel Analyzer



TC 534 Counter and Timer

Ordering Information

Weight (Shipping) 1.0 lbs (0.45 kg)
(Net) 0.2 lbs (0.09 kg)

Instruction manual and performance test record (one each) provided with each detector.

Accessory included One pair of latex gloves is provided to handle your detector.

Shipping Methods We normally ship via U.P.S. Other shipping methods will be followed at your request.

Packaging TENNELEC silicon charged particle detectors are covered with a front-electrode protective cap; placed in a polyethylene hinged-lid container and sealed inside of a moisture-proof, 5 mil plastic bag before being placed in the appropriate shipping container for the shipping method selected. This packaging technique is suitable for all types of surface and air transportation.

Warranty TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

Payment Terms 1% 10, net 30 days.

TENNELEC, INC.
601 Oak Ridge Turnpike, P.O. Box 2560
Oak Ridge, Tennessee 37831-2560 USA
Telephone (615) 483-8405 TWX 810-572-1018

TENNELEC

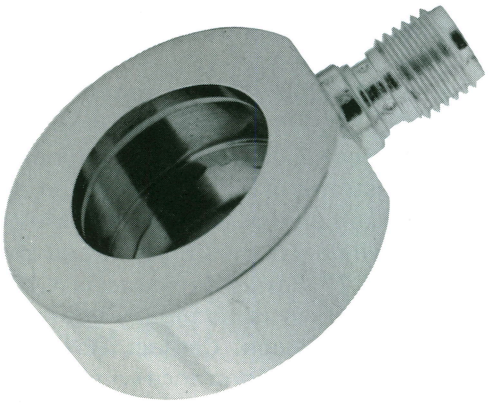
TENNELEC, GmbH
Münchner Strasse 50, D 8025 Unterhaching
West Germany
Telephone 089-611-5060 TLX 841-521 5959 FRIE D

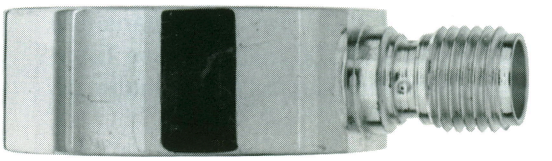
DO 986 3.0K

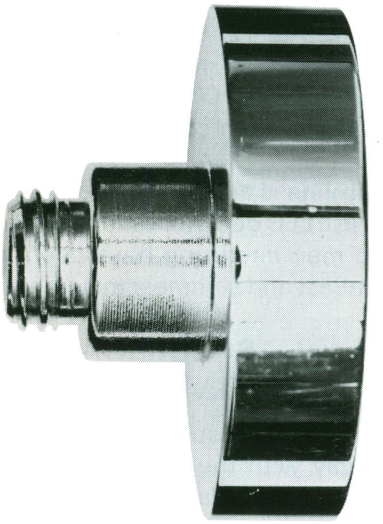
TENNELEC

Selection Guide and Price List

Silicon Charged Particle Detectors







TENNELEC **Silicon Charged Particle Detectors** are available in several active areas from 25 mm^2 to greater than 1000 mm^2, sensitive depths from as thin as 10.1 microns to greater than 1000 microns and in extremely compact, Slimline[1] housings to provide the research and industrial spectroscopist with the correct detector for nearly any application.

TENNELEC's comprehensive line of detectors consists of six (6) series.

- **PD Series** — Partially Depleted
- **PP Series** — Premium Partially Depleted
- **CE Series** — Cleanable Front Electrode
- **TD Series** — Transmission Detector
- **TP Series** — Transmission Planar
- **HI Series** — Heavy Ion

Detector Description

Partially Depleted (PD) Series detectors are available in a wide range of active areas from 25 mm^2 to 1000 mm^2, and sensitive depths from 100 microns to 1000 microns. Three performance categories of alpha resolution and noise are offered (See Table 1). Other sensitive depths and areas are available on special request.

Premium Partially Depleted (PP) Series detectors are the best of the best PD Series detectors and are available in a wide range of active areas from 25 mm^2 to 500 mm^2 and sensitive depths from 100 microns to 500 microns. See Table 2 for a complete selection of available detectors.

Cleanable Front Electrode (CE) Series detectors have a rugged, cleanable aluminum entrance window. These detectors are available in several active areas from 50 mm^2 to 2000 mm^2 and sensitive depths from 100 microns to 500 microns (See Table 3). Other areas and depletion depths are available on special request.

Transmission Detector (TD) Series spectrometers are sensitive through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are typically used in ΔE and timing experiments and are offered in a variety of active areas and thicknesses, from 25 mm^2 to 500 mm^2 and 125 microns to 1050 microns (See Table 4). Other thicknesses and areas are available on special request.

All TD Series detectors are cut off-axis from the original crystal to minimize particle channeling. Specified alpha resolutions for detectors $<$500 microns thick are for alphas incident through the rear (low field) electrode.

Transmission Planar (TP) Series detectors are totally depleted through the entire thickness of the wafer and have uniformly thin entrance and exit windows. These detectors are specially processed for the ultimate in planarity and thickness uniformity across the entire active area. Available in thicknesses from 10.1 microns to 110 microns and active areas from 10 mm^2 to 300 mm^2 (See Table 5). Other thicknesses and areas available on special request.

Heavy Ion (HI) Series detectors are partially depleted to a sensitive depth of $\geqslant$60 microns and manufactured from silicon with characteristics that withstand extremely high electric field strengths ($\geqslant$15,000 volts/cm at the entrance window) without introducing surface multiplication effects. Active areas from 100 mm^2 to 1000 mm^2 are available (See Table 6) with other areas available on special request. All HI series detectors are out off-axis to minimize channeling. Second category devices with a slightly lower field strength are offered.

General Information

Alpha Resolution is warranted as the full peak width at one-half the maximum peak height (Full Width at Half Maximum, FWHM) expressed in keV for Americium -241, 5.486 MeV alphas. Specifications are based on measurements made with standard TENNELEC electronics and an electroplated alpha source and include the electronic noise contribution of the preamplifier.

Beta Resolution is approximately the noise width measured as the full peak width at one-half the maximum peak height (FWHM) expressed in keV for an electronic pulser peak. Measurements are made with standard TENNELEC electronics and include the electronic noise contribution of the preamplifier.

Entrance Window The entrance window for the TENNELEC PD, PP, TD, TP and HI Series detector is $\leqslant$40 μgms/cm^2 Gold, which is nominally equivalent to 800 angstroms of Silicon. Total dead layer does not exceed 20 keV energy loss for 5.486 MeV alphas. The entrance window of the CE Series and exit window of the TD and TP Series detectors is $\leqslant$40 μgms/cm^2 Aluminum, which is nominally equivalent to 2250 angstroms of Silicon. Contact TENNELEC for light tight or other special entrance window requirements.

COLLIMATION All Slimline[1] detectors are designed so that special collimators can be located to within 1 mm (0.040") of the detector entrance window. Internally mounted collimators can be located to within 0.25 mm (0.010") of the entrance window. For more information on collimators, contact the factory.

[1]**Slimline** is an appropriate description of all standard TENNELEC detector mounts. Special efforts in design and manufacturing have been made to provide the smallest and slimmest mount available (See Figure 1).

SPECIFICATION AND DEFINITION STANDARDS

All TENNELEC specifications and definitions of terms comply with the latest revisions of IEEE/ANSI 300 and IEC 333. Warranted performance is for operation in vacuum at 20°C at the amplifier peaking time (T_P) shown. Note: for modern, high performance amplifiers, T_P is approximately two (2) times the shaping time constant.

MOUNT TYPES

TENNELEC silicon charged particle detectors are available in six (6) standard mount types.

Mount Type	Description
CS	Rear SMA connector
CM	Rear Microdot connector
CB	Rear BNC connector
TS	Transmission, side SMA connector
TM	Transmission, side Microdot connector
NH	No housing

MOUNT DIMENSIONS

The following descriptions and dimensions pertain to the mounts illustrated in Figure 1.

R: Distance from the front surface of the housing to the front electrode of the detector: 1 mm (0.040") for Slimline; 0.25 mm (0.010") for unmounted detectors.

T: Thickness of housing:
5.7 mm (0.22 in.) for CS, CM, and CB mounts
6.9 mm (0.27 in.) for TS and TM mounts

D: Outside diameter of housing

C: Collimator diameter (entrance window)

E: Extension length of connector from housing

Mount Type	Dimension
CS	9.2 mm (0.36 in.)
CM	8.3 mm (0.33 in.)
CB	12.2 mm (0.48 in.)
TS	8.1 mm (0.32 in.)
TM	7.4 mm (0.29 in.)

F: Exit aperature diameter

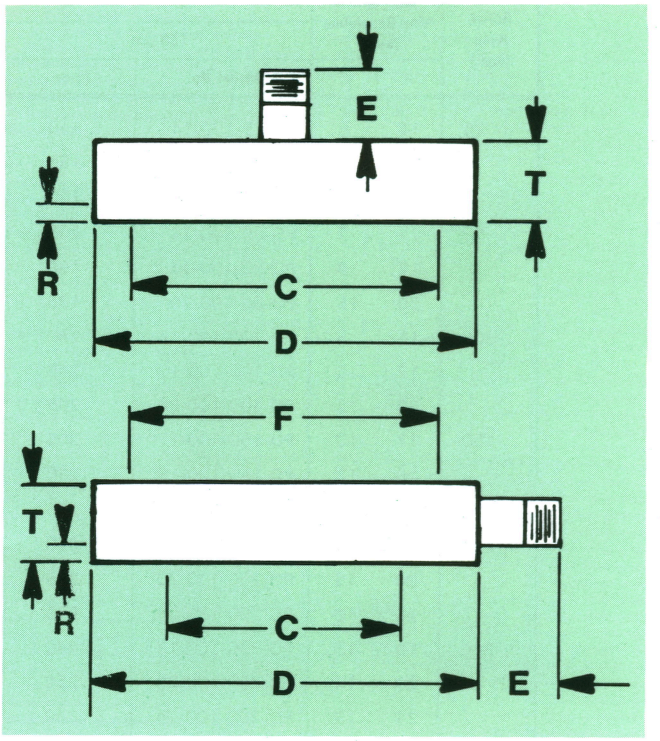


Figure 1

DETECTOR ACTIVE AREA	SLIMLINE COAX MOUNT				SLIMLINE TRANSMISSION MOUNT					
	C		D		C		D		F	
mm²	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
25	5.60	0.22	17.0	0.67	5.60	0.22	18.5	0.73	9.50	0.38
50	7.90	0.31	17.0	0.67	7.90	0.31	18.5	0.73	9.50	0.38
100	11.2	0.44	21.6	0.85	11.2	0.44	22.9	0.90	15.2	0.60
150	13.7	0.54	21.6	0.85	13.7	0.54	22.9	0.90	15.2	0.60
200	15.9	0.63	27.4	1.08	15.9	0.63	28.7	1.13	21.1	0.83
300	19.4	0.77	27.4	1.08	19.4	0.77	28.7	1.13	21.1	0.83
400	22.4	0.88	33.3	1.31	22.4	0.88	34.3	1.35	26.9	1.06
500	25.1	0.99	33.3	1.31	25.1	0.99	34.3	1.35	26.9	1.06
1000	35.6	1.40	43.7	1.72						
2000	50.3	1.98	58.4	2.30						

MODEL NUMBER

TENNELEC detector model numbers fully describe the detector. Below is an illustration of a typical model number, and the information provided.

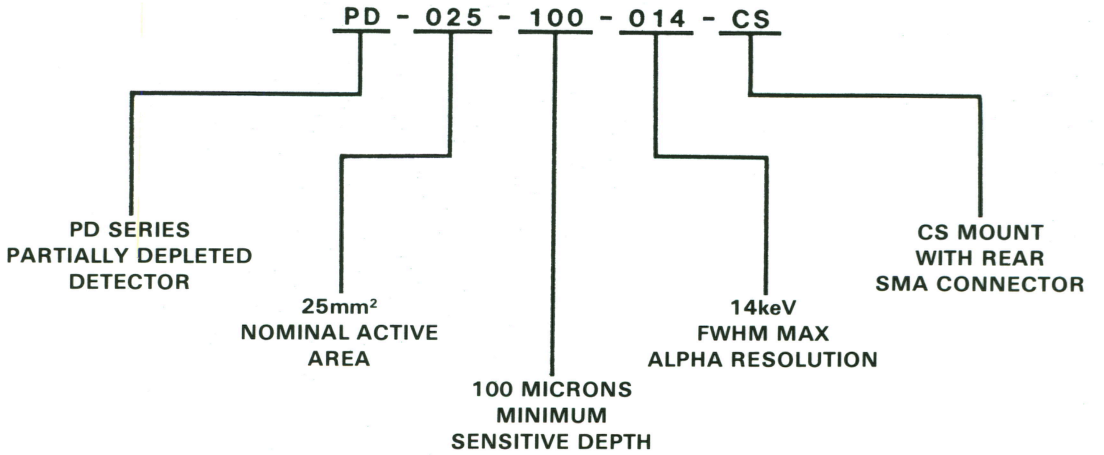


Table 1. PD Series Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	14	6	PD-25-100-14	150	PD-25-300-14	305	PD-25-500-14	535
	15	7	PD-25-100-15	135	PD-25-300-15	230	PD-25-500-15	420
	17	9	PD-25-100-17	130	PD-25-300-17	165	PD-25-500-17	300
50	14	7	PD-50-100-14	205	PD-50-300-14	400	PD-50-500-14	735
	17	9	PD-50-100-17	160	PD-50-300-17	275	PD-50-500-17	460
	20	15	PD-50-100-20	135	PD-50-300-20	140	PD-50-500-20	380
100	16	9	PD-100-100-16	280	PD-100-300-16	495	PD-100-500-16	790
	17	10	PD-100-100-17	215	PD-100-300-17	380	PD-100-500-17	600
	20	15	PD-100-100-20	205	PD-100-300-20	210	PD-100-500-20	455
150	17	10	PD-150-100-17	305	PD-150-300-17	510	PD-150-500-17	800
	19	13	PD-150-100-19	240	PD-150-300-19	360	PD-150-500-19	640
	23	18	PD-150-100-23	225	PD-150-300-23	230	PD-150-500-23	465
200	18	11	PD-200-100-18	360	PD-200-300-18	560	PD-200-500-18	880
	20	16	PD-200-100-20	295	PD-200-300-20	410	PD-200-500-20	705
	24	19	PD-200-100-24	275	PD-200-300-24	320	PD-200-500-24	510
300	19	13	PD-300-100-19	440	PD-300-300-19	680	PD-300-500-19	980
	20	15	PD-300-100-20	350	PD-300-300-20	485	PD-300-500-20	790
	24	19	PD-300-100-24	330	PD-300-300-24	350	PD-300-500-24	575
400	20	16	PD-400-100-20	505	PD-400-300-20	725	PD-400-500-20	1065
	25	20	PD-400-100-25	375	PD-400-300-25	495	PD-400-500-25	810
	29	25	PD-400-100-29	350	PD-400-300-29	390	PD-400-500-29	635
500	25	20	PD-500-100-25	570	PD-500-300-25	775	Special Order	
	30	25	PD-500-100-30	395	PD-500-300-30	510		
1000	45	40	PD-1000-100-45	1075	Special Order		Special Order	
	65	60	PD-1000-100-65	885				
>1000			Special Order		Special Order		Special Order	

Table 2. PP Series Premium Partially Depleted Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth					
			100 μm		300 μm		500 μm	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price
25	12	5	PP-25-100-12	410	PP-25-300-12	565	PP-25-500-12	785
50	13	6	PP-50-100-13	470	PP-50-300-13	660	PP-50-500-13	1015
100	13	7	PP-100-100-13	610	PP-100-300-13	860	PP-100-500-13	1160
150	15	9	PP-150-100-15	670	PP-150-300-15	925	PP-150-500-15	1225
200	16	10	PP-200-100-16	700	PP-200-300-16	1015	PP-200-500-16	1260
300	17	12	PP-300-100-17	825	PP-300-300-17	1125	PP-300-500-17	1360
400	19	14	PP-400-100-19	920	PP-400-300-19	1230	PP-400-500-19	1510
500	21	17	PP-500-100-21	1015	PP-500-300-21	1340	PP-500-500-21	1665

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec. Beta resolution approximated by pulser width FWHM.

[2]Premium performance guaranteed for 3 months. Best category PD Series performance for equivalent size detector guaranteed for remaining 9 months of one (1) year guarantee.

[3]PP Series detectors supplied in CS mount unless specified otherwise by the appropriate suffix.

Table 1. PD Series Continued

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Min Sensitive Depth 1000 μm		Guaranteed Max Resolution (keV)[1]		Min Sensitive Depth >1000 μm
	α	β	Model No.	Price	α	β	Model No.
25	14	6	PD-25-1000-14	900			
	16	9	PD-25-1000-16	685		Special Order	
	18	12	PD-25-1000-18	490			
50	14	7	PD-50-1000-14	1215			
	16	9	PD-50-1000-16	940		Special Order	
	18	12	PD-50-1000-18	785			
100	15	9	PD-100-1000-15	1330			
	19	23	PD-100-1000-19	1220		Special Order	
	24	19	PD-100-1000-24	895			
150	17	10	PD-150-1000-17	1360			
	19	13	PD-150-1000-19	1280		Special Order	
	24	19	PD-150-1000-24	925			
200	18	11	PD-200-1000-18	1585			
	21	16	PD-200-1000-21	1490		Special Order	
	24	19	PD-200-1000-24	1060			
300	18	13					
	21	16	Special Order				
	24	19					
400	21	16					
	26	21	Special Order				
	30	25					

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec. Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]PD Series detectors supplied in CS mount unless specified otherwise by the appropriate suffix.

Table 3. CE Series Cleanable Front Electrode Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum-Sensitive Depth 100 μm		Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth 300 μm		500 μm		1000 μm
	α	β	Model No.	Price	α	β	Model No.	Price	Model No.	Price	Model No.
50	17	8	CE-50-100-17	355	17	8	CE-50-300-17	505	CE-50-500-17	950	Special Order
	19	15	CE-50-100-19	285	19	15	CE-50-300-19	390	CE-50-500-19	770	
100	18	10	CE-100-100-18	400	17	9	CE-100-300-17	585	CE-100-500-17	1040	Special Order
	20	14	CE-100-100-20	320	20	15	CE-100-300-20	450	CE-100-500-20	850	
150	19	11	CE-150-100-19	450	17	9	CE-150-300-17	665	CE-150-500-17	1125	Special Order
	21	15	CE-150-100-21	355	21	15	CE-150-300-21	505	CE-150-500-21	935	
300	21	15	CE-300-100-21	675	20	14	CE-300-300-20	830	CE-300-500-20	1340	Special Order
	24	18	CE-300-100-24	535	24	15	CE-300-300-24	635	CE-300-500-24	1105	
400	24	19	CE-400-100-24	755	24	18	CE-400-300-24	1005	CE-400-500-24	1475	Special Order
	27	22	CE-400-100-27	585	27	22	CE-400-300-27	795	CE-400-500-27	1225	
500	33	28	CE-500-100-33	835	33	29	CE-500-300-33	1180	CE-500-500-33	1615	Special Order
	36	31	CE-500-100-36	645	36	31	CE-500-300-36	955	CE-500-500-36	1350	
1000	45	40	CE-1000-100-45	1450	53	48	CE-1000-300-53	1995	CE-1000-500-53	3035	
2000	80	75	CE-2000-100-80	2455	80	75	CE-2000-300-80	3065	CE-2000-500-80	3685	

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec. Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]CE Series detectors supplied in CS mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Transmission Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)							
			150 μm (125-175 μm)		200 μm (176-225 μm)		250 μm (226-275 μm)		300 μm (276-350 μm)	
	α	β	Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
25	16	7	TD-25-150-16	280	TD-25-200-16	300	TD-25-250-16	315	TD-25-300-16	335
	18	9	TD-25-150-18	215	TD-25-200-18	235	TD-25-250-18	250	TD-25-300-18	265
50	16	7	TD-50-150-16	390	TD-50-200-16	410	TD-50-250-16	425	TD-50-300-16	450
	18	9	TD-50-150-18	290	TD-50-200-18	305	TD-50-250-18	320	TD-50-300-18	340
100	17	9	TD-100-150-17	475	TD-100-200-17	510	TD-100-250-17	525	TD-100-300-17	555
	19	10	TD-100-150-19	360	TD-100-200-19	390	TD-100-250-19	400	TD-100-300-19	420
150	18	10	TD-150-150-18	510	TD-150-200-18	565	TD-150-250-18	585	TD-150-300-18	665
	20	13	TD-150-150-20	390	TD-150-200-20	430	TD-150-250-20	445	TD-150-300-20	505
200	19	13	TD-200-150-19	560	TD-200-200-19	595	TD-200-250-19	625	TD-200-300-19	715
	22	17	TD-200-150-22	450	TD-200-200-22	485	TD-200-250-22	505	TD-200-300-22	555
300	20	15	TD-300-150-20	675	TD-300-200-20	705	TD-300-250-20	725	TD-300-300-20	740
	23	18	TD-300-150-23	500	TD-300-200-23	520	TD-300-250-23	540	TD-300-300-23	575
400	24	19	TD-400-150-24	720	TD-400-200-24	755	TD-400-250-24	785	TD-400-300-24	800
	27	21	TD-400-150-27	550	TD-400-200-27	575	TD-400-250-27	600	TD-400-300-27	640
500	26	21	TD-500-150-26	765	TD-500-200-26	810	TD-500-250-26	845	TD-500-300-26	860
	30	25	TD-500-150-30	605	TD-500-200-30	630	TD-500-250-30	665	TD-500-300-30	725

[1]Guaranteed alpha resolution is through the rear electrode (for thickness ≤500 μm), FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec. Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for one (1) year.

[3]TD Series detectors supplied in TS mount unless specified otherwise by the appropriate suffix.

Table 5. TP Series Transmission Planar Detectors

Active Area (mm^2)	Maximum Thickness Variation (Microns)	Depletion Depth (Range)							
		15 μm (10.1-15 μm)		20 μm (15.1-20 μm)		25 μm (20.1-25 μm)		30 μm (25.1-35 μm)	
		Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
10	±0.5	TP-10-15-20	1535						
25	±0.5	TP-25-15-25	1740	TP-25-20-20	1415	TP-25-25-15	1090	TP-25-30-15	875
50	±0.5	TP-50-15-35	1900	TP-50-20-30	1620	TP-50-25-25	1545	TP-50-30-25	1205
100	±1.0			TP-100-20-40	2405	TP-100-25-35	1835	TP-100-30-30	1475
150	±1.0			TP-150-20-60	2745	TP-150-25-55	2075	TP-150-30-40	1645
200	±1.0			TP-200-20-75	2920	TP-200-25-60	2190	TP-200-30-45	1745
300	±1.0					TP-300-25-80	2635	TP-300-30-55	2110

[1]Last two (2) digits of model number indicate total system noise width FWHM using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec, for the thinnest detector (highest capacitance) in each thickness range.

[2]≤25 micron thick detectors warranted for three (3) months.
≥25 micron thick detectors warranted for one (1) year.

[3]TP Series detectors are supplied in TS mount unless specified otherwise by the appropriate suffix.

Table 4. TD Series Continued

400 μm (351-450 μm)		Guaranteed Max Resolution (keV)[1]		Depletion Depth (Range)					
				500 μm (451-550 μm)		700 μm (650-750 μm)		1000 μm (950-1050 μm)	
Model No.	Price	α	β	Model No.	Price	Model No.	Price	Model No.	Price
TD-25-400-16	480	16	8	TD-25-500-16	630	TD-25-700-16	955	TD-25-1000-16	1235
TD-25-400-18	340	18	10	TD-25-500-18	445	TD-25-700-18	545	TD-25-1000-18	740
TD-50-400-16	605	16	8	TD-50-500-16	885	TD-50-700-16	1090	TD-50-1000-16	1360
TD-50-400-18	465	18	10	TD-50-500-18	570	TD-50-700-18	700	TD-50-1000-18	1040
TD-100-400-17	705	17	10	TD-100-500-17	940	TD-100-700-17	1215	TD-100-1000-17	1485
TD-100-400-19	545	20	13	TD-100-500-20	635	TD-100-700-20	825	TD-100-1000-20	1380
TD-150-400-18	740	18	10	TD-150-500-18	955	TD-150-700-18	1290	TD-150-1000-18	1620
TD-150-400-20	565	21	13	TD-150-500-21	765	TD-150-700-21	880	TD-150-1000-21	1510
TD-200-400-19	800	19	13	TD-200-500-19	1050	TD-200-700-19	1395	TD-200-1000-19	1745
TD-200-400-22	595	22	15	TD-200-500-22	850	TD-200-700-22	1115	TD-200-1000-22	1635
TD-300-400-20	910	20	14	TD-300-500-20	1160	TD-300-700-20	1545	TD-300-1000-20	1935
TD-300-400-23	690	23	18	TD-300-500-23	940	TD-300-700-23	1085	TD-300-1000-23	1820
TD-400-400-24	980	22	17	TD-400-500-22	1240	TD-400-700-22	1640	Special Order	
TD-400-400-27	750	27	22	TD-400-500-27	1000	TD-400-700-27	1235		
TD-500-400-26	1055	24	19	TD-500-500-24	1320	TD-500-700-24	1740	Special Order	
TD-500-400-30	810	29	25	TD-500-500-29	1065	TD-500-700-29	1390		

Table 5. TP Series Continued

Active Area (mm^2)	Maximum Thickness Variation (Microns)	Depletion Depth (Range)							
		40 μm (35.1-45 μm)		50 μm (45.1-65 μm)		75 μm (65.1-85 μm)		100 μm (85.1-110 μm)	
		Model No.	Price	Model No.	Price	Model No.	Price	Model No.	Price
10	±0.5								
25	±0.5	TP-25-40-15	815	TP-25-50-15	695	TP-25-75-15	665	TP-25-100-15	590
50	±0.5	TP-50-40-20	1090	TP-50-50-15	955	TP-50-75-15	845	TP-50-100-15	755
100	±1.0	TP-100-40-25	1295	TP-100-50-25	1090	TP-100-75-20	990	TP-100-100-20	900
150	±1.0	TP-150-40-35	1420	TP-150-50-30	1190	TP-150-75-30	1075	TP-150-100-25	955
200	±1.0	TP-200-40-40	1595	TP-200-50-35	1395	TP-200-75-35	1155	TP-200-100-25	1030
300	±1.0	TP-300-40-50	1910	TP-300-50-45	1545	TP-300-75-40	1345	TP-300-100-30	1255

Table 6. HI Series Heavy Ion Detectors

Active Area (mm^2)	Guaranteed Max Resolution (keV)[1]		Minimum Sensitive Depth ⩾60 μm	
	α	β	Model No.	Price
100	25	20	HI-100-60-25	410
	30	25	HI-100-60-30	270
300	30	25	HI-300-60-30	540
	40	35	HI-300-60-40	405
400	35	30	HI-400-60-35	785
	45	40	HI-400-60-45	650
500	40	35	HI-500-60-40	1030
	60	55	HI-500-60-60	900
1000	45	40	HI-1000-60-45	1955
	95	90	HI-1000-60-95	1820

Note: All HI Series Detectors are ultra-close mount (⩽0.040")

[1]Guaranteed alpha resolution is through the front electrode, FWHM for Am-241, 5.486 MeV alphas, using standard Tennelec electronics at an amplifier peaking time (Tp) of 1 μsec. Maximum field strength is ⩾15 kV/cm. for first category and ⩾10 kV/cm. for second category detectors. Active surface <1 mm from front of housing. Beta resolution approximated by pulser width FWHM.

[2]Performance guaranteed for six (6) months (does not include leakage current increases due to radiation damage).

[3]HI Series detectors supplied in CS mount unless specified otherwise by the appropriate suffix.

Ordering Information

Weight (Shipping) 1.0 lbs (0.45 kg)
(Net) 0.2 lbs. (0.09 kg)

Instruction manual and performance test record (one each) provided for each detector shipped.

Accessory included One pair of latex gloves is provided to handle your detector.

Shipping Methods We normally ship via Air Parcel Post. Other shipping methods will be followed at your request.

Packaging TENNELEC silicon charged particle detectors are covered with a front-electrode protective cap; placed in a polyethylene hinged-lid container; heat-sealed inside of a moisture-proof, 5 mil plastic bag and packed in a cardboard carton before being placed in the appropriate shipping container for the shipping method selected. This packaging technique is suitable for all types of surface and air transportation.

Warranty TENNELEC products are designed and manufactured to strict quality standards. A warranty statement is furnished with each instrument. In the case of instruments supplied by TENNELEC but not originally manufactured by TENNELEC, the benefits of the original manufacturer's warranty are passed on to the customer.

Prices All prices listed herein are in U.S. currency, f.o.b. Oak Ridge, Tennessee, and are subject to change without notice. Prices listed do not include shipping or local taxes. Minimum order $25.00.

Payment Terms 1% 10, net 30 days.

TENNELEC INC.

601 Turnpike, Oak Ridge, Tennessee 37830 USA
Telephone 615-483-8405/TWX 810-572-1018

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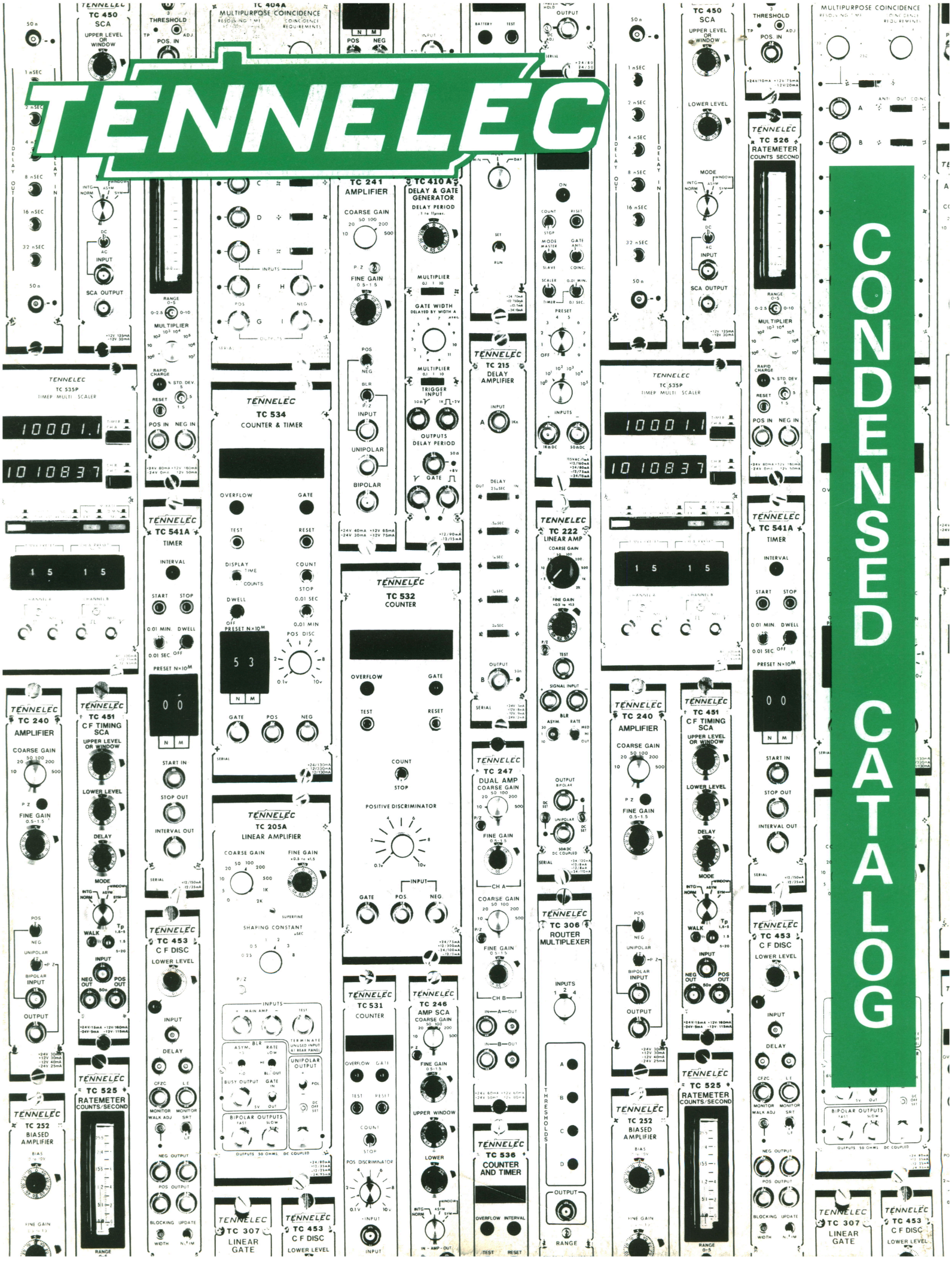
Muenchner Strasse 50, D 8025 Unterhaching West Germany
Telephone 089/611-5060/TLX 5215959 FRIE D

TENNELEC

CONDENSED CATALOG



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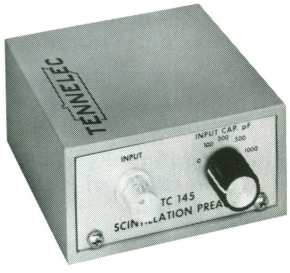
For more detailed information about any of Tennelec's products, contact:

TENNELEC INC.

601 Oak Ridge Turnpike
Post Office Box 2560
Oak Ridge, Tennessee 37830-2560 USA
Phone (615) 483-8405 TWX 810-572-1018
or

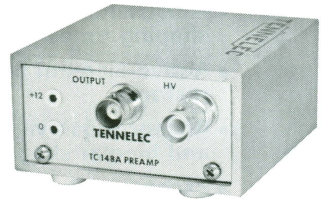
Your Local Tennelec Sales Representative

TC 145
Scintillation Preamplifier



- Fast Risetime
- Protected Input
- Switch-selectable input capacitance
- Compact

TC 148A
GM Tube Preamplifier

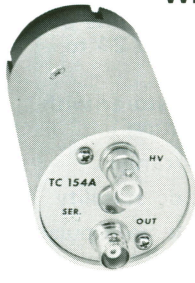


- Powered from Detector Bias Supply
- Charge Sensitive

TC 154
Photomultiplier Tube Base

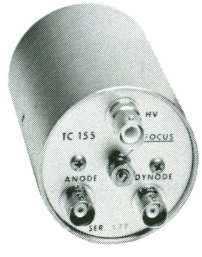
- Compact
- Linear output signals from both the anode and tenth dynode
- Mounts directly to 12 pin PMT

TC 154A
Photomultiplier Tube Base With Preamplifier



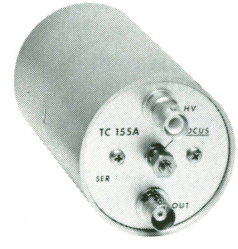
- TC 154 with built-in charge sensitive preamplifier
- No external power required for preamplifier
- Compact

TC 155
Photomultiplier Tube Base



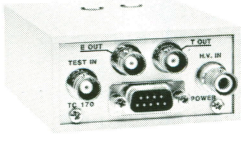
- Compact
- Focus control for optimum performance
- Linear output available from anode and ninth dynode
- Mounts directly to 14 pin PMT

TC 155A
Photomultiplier Tube Base With Preamplifier



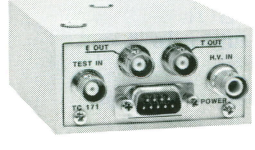
- TC 155 with built-in charge sensitive preamplifier
- No external power required for preamplifier
- Focus control for optimum performance
- Compact

TC 170
Preamplifier



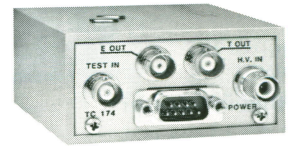
- Low-noise charge-sensitive design
- Optimized for low capacitance charged particle detectors
- Independent energy and timing outputs

TC 171
Preamplifier



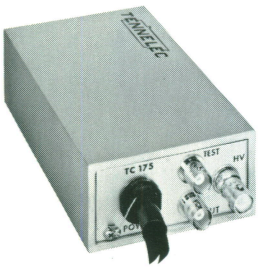
- Low-noise charge-sensitive design
- Optimized for high capacitance charged particle detectors
- Independent energy and timing outputs

TC 174
Preamplifier



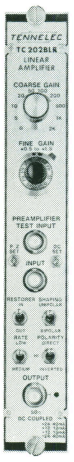
- Economical charge-sensitive design
- Designed for general purpose applications
- Energy and timing outputs
- Built-in HV protection

TC 175
Preamplifier



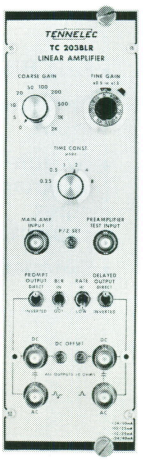
- Especially designed for large area proportional counters
- Low noise
- Detector bias up to ± 5kV
- Excellent integral linearity and temperature stability

TC 202 BLR
Linear Amplifier



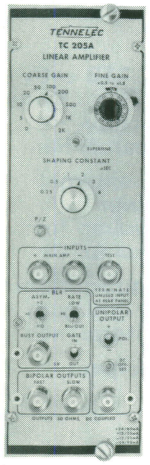
- Four switch-selectable shaping times
- Active-element baseline restorer
- Accepts positive, negative and bipolar shaped inputs
- Exceptionally wide gain range of X2.5 to X3000

TC 203 BLR
Linear Amplifier



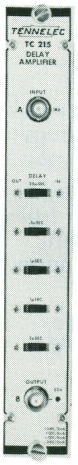
- Five shaping times
- Active-element baseline restorer
- Unipolar and bipolar prompt and delayed outputs
- Exceptionally wide gain range of X2.5 to X3000
- Accepts positive, negative and bipolar shaped inputs

TC 205A
Research Amplifier



- Gain from X 2.5 to X 3000
- Six selectable shaping times
- Crossover Walk < 1.0 nsec
- Less than 0.03% peak shift from 0 to 250 kHz
- Noise less than 3.75 μV
- 0.25 μsec Fast Bipolar output

TC 215
Delay Amplifier



- dc-coupled
- Input impedance independent of delay
- Delay from 0 to 4.75 μsec
- High counting rate capability

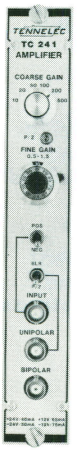
TC 222
Linear Amplifier

- Nine shaping time constants from 0.24 to 15 μsec
- Baseline restorer with internal gating
- Wide gain range
- Excellent dc stability
- Compatible with pulsed optical feedback preamplifiers

TC 240
Amplifier

- Noise less than 5.0 μV
- Economical
- High count rate capability
- Four active integrator stages
- 2.0 μsec peaking time
- Excellent dc stability
- Unipolar or bipolar output

TC 241
Amplifier

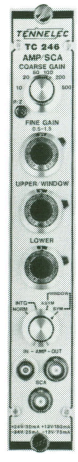


- Excellent dc stability
- Automatic BLR threshold and rate control
- Gated baseline restorer
- High count rate capability
- Three selectable peaking times; 1, 3 and 6 μsec
- Unipolar and bipolar outputs

TC 242
Spectroscopy Amplifier

- Excellent dc stability
- Automatic BLR threshold and rate control
- Asymmetric or symmetric gated baseline restorer
- Ultra high count rate capability
- Six selectable peaking times; 1, 2, 4, 8, 16 and 24 μsec
- Unipolar and bipolar outputs
- Differential input capability

TC 246
Amplifier and Single Channel Analyzer



- Amplifier
  - Noise <5 μV
  - Four Active Integrator Stages
  - 2.0 μsec Peaking Time
  - Unipolar or Bipolar Output
- Single Channel Analyzer
  - Four Operational Modes:
    - Integral
    - Normal
    - Asymmetrical Window
    - Symmetrical Window
  - SCA, UL and LL Outputs
- High count rate capability
- Excellent dc stability

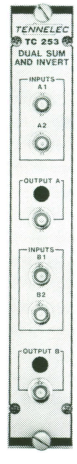
TC 247
Dual Amplifier

- Two amplifiers in one single-width NIM module
- Noise less than 5.0 μV
- Economical
- High count rate capability
- Four active integrator stages
- 2.0 μsec peaking time
- Excellent dc stability
- Unipolar or bipolar output

TC 252
Biased Amplifier

- dc-coupled for high count rate
- Excellent temperature and gain stability
- Spectrum expansion
- Continuously adjustable gain
- Single-width NIM module

TC 253
Dual Sum and Invert Amplifier



- Two independent, four input summing amplifiers
- Wide dynamic range, 0 to ± 10 volts
- Wide bandwidth, 0 to 6 MHz
- LED output indicators
- Low noise, < 5 μV rms
- Single-width NIM module

TC 256
Alpha Spectrometer

- Silicon detector alpha spectrometer
- Incorporates a vacuum chamber, preamplifier, amplifier, high voltage power supply, and test pulser in a two-wide NIM module
- Calibrated output for selected energy ranges
- Logic output for gross alpha counting
- Horizontal sample orientation

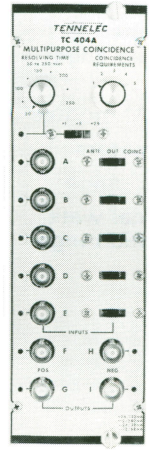
TC 306
Router/Multiplexer

- Multiplex and route up to 4 inputs
- Independently adjustable thresholds
- No multiple input noise summation
- Analog routing technique eliminates complex I/F
- Universally accepted output

TC 307
Linear Gate

- Single-width NIM module
- Gate normally open or normally closed
- LED output indicator
- Accepts dc inputs with amplitudes up to 45 volts

TC 404A
Multipurpose Coincidence

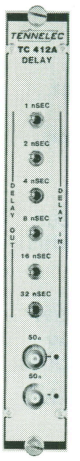


- dc-coupled
- Adjustable resolving time
- Coincidence or anticoincidence mode
- Five inputs
- Four buffered outputs, two positive and two negative

TC 410A
Delay and Gate Generator

- Provides delay times from 100 nsec to 110 μsec
- Excellent time delay stability
- Accepts either positive or negative logic signals
- Excellent linearity

TC 412A
Nanosecond Delay

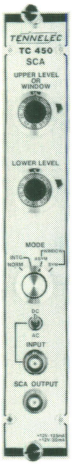


- No power required
- Delays up to 63 nanoseconds in 1 nsec steps
- Excellent accuracy
- Single-width NIM module

TC 446
Crossover Pickoff

- Accepts 0 to $\pm$10V, positive lobe leading bipolar inputs
- $\leqslant$ 1 nsec walk for 10:1 dynamic range
- Output delay from 0.1 to 1.1 μsec or 1.0 to 11 μsec

TC 450
Single Channel Analyzer



- Exceptionally wide dynamic range
- NIM-standard single-width module
- Accepts positive unipolar or bipolar pulses either RC or delay-line shaped
- Four modes of operation:
  - Integral
  - Normal
  - Asymmetrical window
  - Symmetrical window

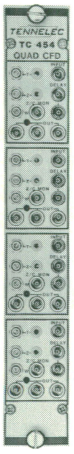
TC 451
Constant Fraction Timing Single Channel Analyzer

- Constant fraction timing
- $<\pm$3 nsec walk over 100:1 dynamic range
- Four operational modes:
  - Integral
  - Normal
  - Asymmetrical window
  - Symmetrical window
- Positive and negative SCA outputs
- Upper and lower level outputs
- Adjustable delay

TC 453
100 MHz Constant Fraction Discriminator

- 100 MHz count rate capability
- 1000:1 dynamic range
- Typical walk $<\pm$50 psec for 100:1 dynamic range
- Three operating modes
  - Constant fraction
  - Slow rise time reject
  - Leading edge
- Selectable fraction
- Fixed or updating dead time operation
- Positive and negative outputs

TC 454
Quad Constant Fraction Discriminator



- 200 MHz constant fraction or leading edge capability
- Single-width NIM module
- LED output indicators
- 1000:1 dynamic range
- $<\pm$50 psec typical walk for 100:1 dynamic range

TC 525
1 MHz Ratemeter

- Precise, stable linear count ratemeter
- Fifteen count rate ranges provided from 25 to 1,000,000 counts per second
- Built-in integral discriminator
- Selectable recorder output

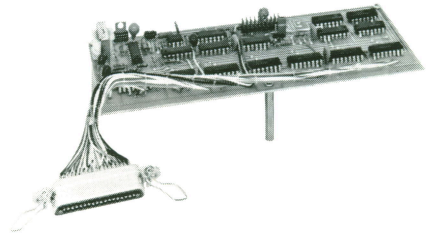
TC 526
100 MHz Ratemeter

- Ultra stable, linear ratemeter
- Unique digital rate measurement technique
- 2.5 to 100,000,000 counts per second
- Built-in integral discriminator
- Selectable recorder output
- Exclusive Rapid Charge Feature

TC 529
Alarm Control

- Two alarm set points
- Separate power control relay
- 0-10 V or 0-1 V input range
- Manual or automatic reset modes
- Independent discriminator outputs

TC 530-01
Parallel Output Option

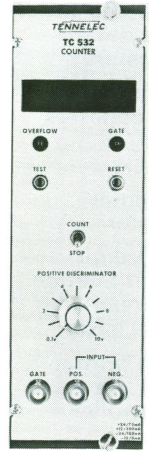


- Provides parallel BCD data
- Buffered for fast data transfer
- Field installable in TC 532, TC 533 or TC 534

TC 531
Counter

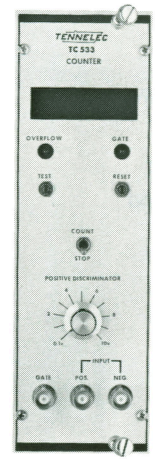
- High Performance, low cost
- 100 MHz negative and 25 MHz positive input counting capability
- Adjustable positive input discriminator
- Six-decade LED display with leading zeros suppressed and test push-button
- Gate input and overflow output with LED indicators

TC 532
Counter



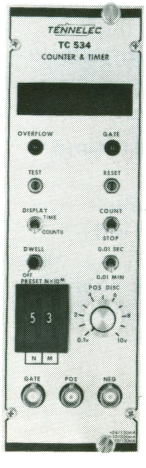
- High Performance, Low-Cost Counter
- 100 MHz negative and 25 MHz positive input
- Seven-decade LED display with leading zeros suppressed and test push-button
- Adjustable positive input discriminator
- Gate input and overflow output with LED indicators
- Parallel output option

TC 533
Counter



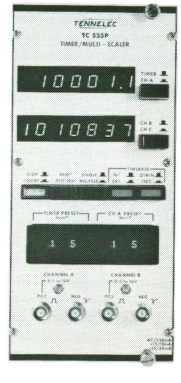
- 100 MHz negative and 25 MHz positive input
- Seven-decade LED display with leading zeros suppressed and test push-button
- Full print logic
- Gate input and overflow output with LED indicators
- Parallel output option

TC 534
Counter and Timer



- 7-decade LED display
- Simultaneous counter and timer operation
- 100 MHz negative and 25 MHz positive input counting capability
- Full print logic
- Crystal controlled timebase

TC 535P
Timer/Multiscaler



- Three seven-decade counters and a timer
- 85 MHz guaranteed count rate
- Crystal controlled timebase
- Full print logic
- Adjustable positive input discriminators

TC 536
Counter and Timer

- Simultaneous counter and timer operation
- 100 MHz negative and 25 MHz positive input counting capability
- Adjustable positive input discriminator
- Crystal controlled timebase

TC 541A
Timer

- Crystal controlled time-base for less than 0.0005% inaccuracy
- Single cycle or Recycle mode
- Time range from 0.01 sec to 900,000 min.
- Time gate for dead time corrections

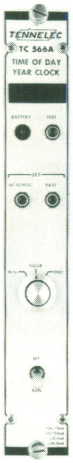
TC 546P
Counter

- Six decade LED display
- Full print logic
- Single-width NIM module
- 20 MHz positive and negative inputs
- Gated operation
- Overflow output

TC 547P
Timer or Counter

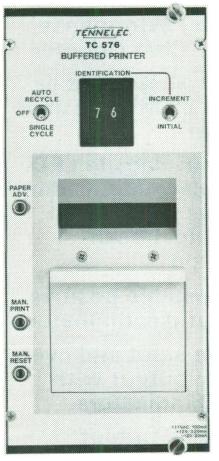
- Preset counter or timer operation
- Six decade LED display
- Full print logic
- Single-width NIM module
- 20 MHz positive and negative inputs
- Gated operation

TC 566A
Time of Day/ Time of Year Clock



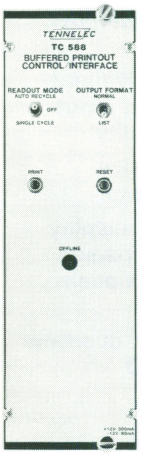
- Single-width NIM module
- Full print logic
- Battery-back-up
- Crystal controlled timebase

TC 576
Buffered Printer



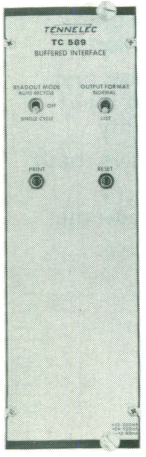
- Buffered for fast data transfer
- Prints up to 50 counters and/or timers
- Thermal printer
- Two digit identification for manual data entry
- Line printer and printout controller

TC 588
Buffered Printer Interface



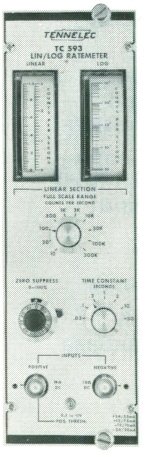
- Programmable
- Buffered for fast data transfer
- Both RS-232-C and 20 mA current loop communications links
- Adjustable baud rate
- Controllable from keyboard or software

TC 589
Buffered Interface



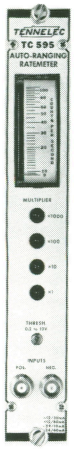
- Programmable
- Buffered for fast data transfer
- Both IEEE Standard 488 and 20 mA current loop communications links
- Adjustable baud rate
- Controllable from keyboard or software

TC 593
Lin/Log Ratemeter



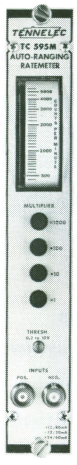
- Simultaneous linear and log recorder outputs
- 0 to 100% zero suppression
- Seven linear time constants
- Simultaneous linear and log displays
- Adjustable positive input discriminator

TC 595
Autoranging Ratemeter



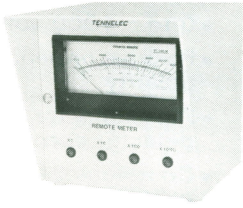
- Counts per second ratemeter
- 10 to 100,000 cps
- Four range multipliers with LED indicators
- Automatically selects correct range for the input count rate

TC 595M
Autoranging Ratemeter



- Counts per minute ratemeter
- 500 to 5,000,000 cpm
- Four range multipliers with LED indicators
- Automatically selects correct range for the input count rate

TC 595RM
Remote Meter

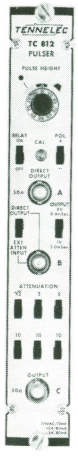


- Used with TC 595 or TC 595M ratemeters
- Meter has cps and cpm scales
- Range multiplier LEDs
- Up to 500 feet from ratemeter
- 50 foot cable provided

TC 599
Howler

- Audible tone frequency varies directly with count rate
- Trigger point adjustable from 0 to 100%
- Volume control
- Compatible with any ratemeter

TC 812
Pulser

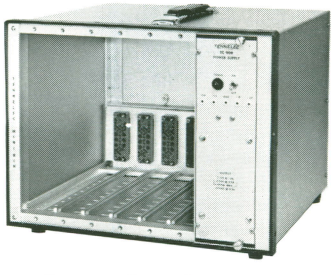


- Simulates detector output signals
- Direct and attenuated outputs
- Can be calibrated to read directly in units of energy
- Essentially independent of supply voltage changes

TC 861A
Time-to-Amplitude Converter

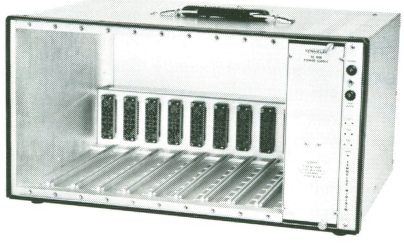
- Full scale time ranges from 50 nsec to 50 μsec
- Coincident or anticoincident gate
- Internal or external strobe
- Adjustable output delay and width

MB 1/TC 909
Minibin and Power Supply



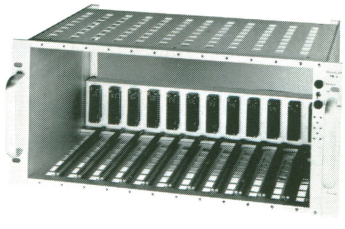
- Power Supply exceeds NIM recommended specifications
- Parallel wiring for lower impedance and less variation of power level
- Six NIM slots

MB 2/TC 910
Midibin and Power Supply



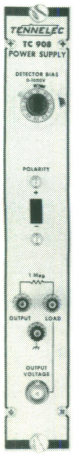
- Power Supply exceeds NIM recommended specifications
- Parallel wiring for lower impedance and less variation of power level
- Ten NIM slots

TB3/TC 911
TB3/TC 911-6
NIM Bin and Power Supply



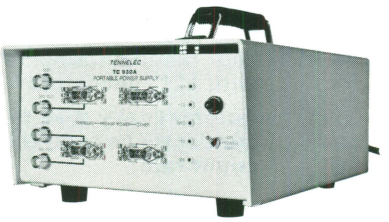
- Exceeds TID-20893 (Rev.) recommended specifications
- Adjustment-free extruded BIN construction
- Parallel (bussed) power distribution
- 115 V or 230 V ac operation
- Twelve NIM slots

TC 908
Detector Bias Supply



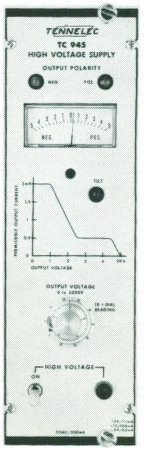
- 0 to ± 1000 volts, 50 μA
- Positive or negative polarity
- Provisions for monitoring detector currents
- Continuously variable output
- Noise and ripple less than 2 mV

TC 930A
Portable Preamp Power Supply



- Power for 4 Preamps
- Power for 1 NIM module
- Compact and portable
- 115 or 230 Vac operation

TC 945
High Voltage Supply



- 50 to ±5000 V, 2 mA to 10 μA
- Front-panel meter
- Fault protection
- Remote disable input
- Noise and ripple less than 10 mV

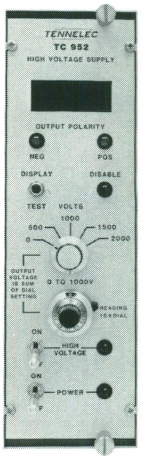
TC 948
High Voltage Supply

- 0 to +1500 V dc at 1 mA
- Automatic Fault Protection
- Single-width NIM Module
- Noise and ripple less than 10 mV

TC 950
Detector Bias Supply

- 0 to ± 5 kV and 0 to ± 500 V simultaneous outputs
- Positive or negative output polarity
- 5-turn direct-reading voltage control
- Front-panel meter
- Receives power from NIM Bin Supply
- Noise and ripple less than 5 mV

TC 952
High Voltage Power Supply



- ±10 to ±3000 V, 0 to 10 mA
- Output controllable by external input
- Remote disable input
- Overload and short-circuit protected
- LED display of voltage and polarity

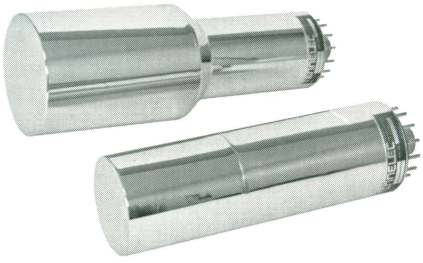
SILICON CHARGED PARTICLE DETECTORS

- **Six types of detectors are available:**
  - — Partially depleted — PD Series
  - — Premium Partially depleted — PP Series
  - — Cleanable front electrode — CE Series
  - — Transmission detector — TD Series
  - — Transmission planar — TP Series
  - — Heavy Ion — HI Series
- **Six standard mount types are available**

Mount Type	Description
CS	Rear SMA connector
CM	Rear Microdot connector
CB	Rear BNC connector
TS	Transmission, side SMA connector
TM	Transmission, side Microdot connector
NH	No housing

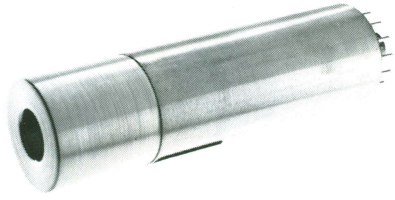
- **Slimline ultra thin mounts for tight spacing**

NaI(Tl)
Right Circular Cylinders



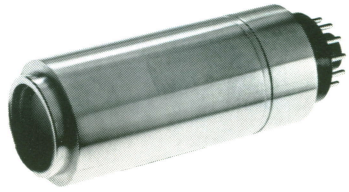
- TD 25S25 1.0" x 1.0", 2" PMT
- TD 38S38 1.5" x 1.5", 2" PMT
- TD 51S51 2.0" x 2.0", 2" PMT
- TD 76S76 3.0" x 3.0", 3" PMT

NaI(Tl)
Well Detectors



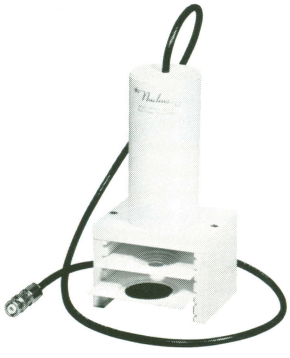
- TD 51SP51
  2" x 2" with 1" x 1.546" well
  2" PMT
- TD 76SP76
  3" x 3" with 1" x 2.046" well
  3" PMT

NaI(Tl)
Thin Window X-Ray Detectors



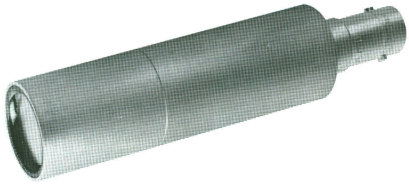
- TD 25SX1
  1" x 1 mm thick
- TD 38SX2
  1.5" x 2 mm thick
- 5 mil Be window
  1.5" PMT

GM Detectors



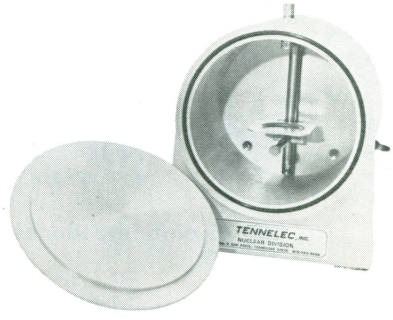
- TD 2902 0.6" diameter
- TD 2903 1.1" diameter
- Planchet holder base

Proportional Counters



- TD 2904 0.5" diameter
- TD 2905 1.0" diameter
- SHV connector

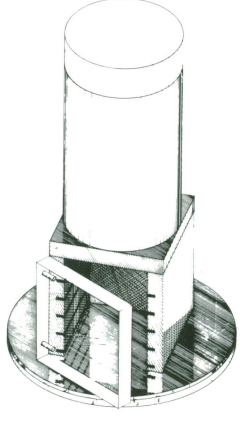
TL 910
Vacuum Chamber

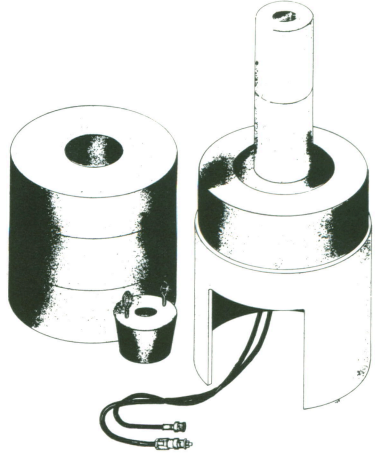


- Front access
- Adjustable sample to detector spacing
- Horizontal sample orientation

LEAD SHIELDS

- Planchet holder base
- Low background lead
- Accommodates NaI(Tl) GM, and proportional detectors
- Modular "donut" ring design





TC 2902G	1" diameter GM and PC detectors
TC 2902CD	1" or 2" diameter NaI(Tl) detectors
TC 2903CD	3" diameter NaI(Tl) detectors

TC 2902C	1" or 2" NaI(Tl) solid top plug
TC 2902W	top plug with access hole
TC 2903C	3" dia. NaI(Tl), solid top plug
TC 2903W	top plug with access hole

Preamplifier Signal and Power Cables

NC-OPA-06 6 feet long
NC-OPA-12 12 feet long

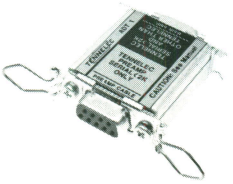
- For TENNELEC preamplifiers SN's < 2000

NC-PAC-10 10 feet long

- For TENNELEC preamplifiers SN's > 2000

Adapters

ADT-1 Preamp Power Adapter



- Permits proper interface and powering of TENNELEC preamplifiers SN's < 2000 by TENNELEC amplifiers SN's > 2000 and other commercially available amplifiers

NC-MTB BNC to Microdot® Adapter

- BNC (Male) to Microdot (Female) adapter for use in TC 256, etc.

Signal Cables

RG-58, 50 ohm BNC-BNC

NC-581-0.5	0.5′
NC-581-01	1′
NC-581-02	2′
NC-581-06	6′
NC-581-12	12′

RG-62, 93 ohm, BNC-BNC

NC-621-0.5	0.5′
NC-621-01	1′
NC-621-02	2′
NC-621-06	6′
NC-621-12	12′

High Voltage Cables

RG-59, 75 ohm impedance H.V. Cables

NC-592-02	2′, BNC to MHV
NC-593-06	6′, MHV to MHV
NC-593-12	12′, MHV to MHV
NC-594-02	2′, BNC to SHV
NC-595-06	6′, SHV to SHV
NC-595-12	12′, SHV to SHV
NC-596-06	6′, SHV to MHV
NC-596-12	12′, SHV to MHV

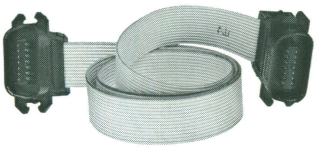
BNC-Tee Connector

- One male, two female

NC-TERM-50/ NC-TERM-93 BNC TERMINATORS

- 50 ohm and 93 ohm

Miscellaneous Cables



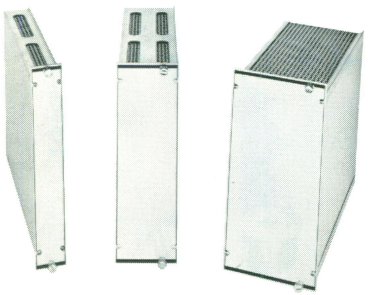
NC-ODA-2

NC-ODA-2 2 foot data acquisition cable (Amphenol 552929-1 connectors)

NC-EXC-4 4 foot module extender cable (Amphenol 202516-3 and 202515-5 connectors)

NC-SBCA-05 5 foot cable from module slot in TB3 to PG-13 of slave bin

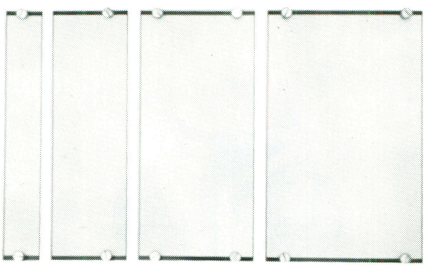
Blank NIM Modules



NIM-B1W	1 wide
NIM-B2W	2 wide
NIM-B3W	3 wide
NIM-B4W	4 wide

- Includes power connector pins and wire

Blank NIM Panels



NIM-BP1	1 wide
NIM-BP2	2 wide
NIM-BP3	3 wide
NIM-BP4	4 wide

Instrument Cabinets

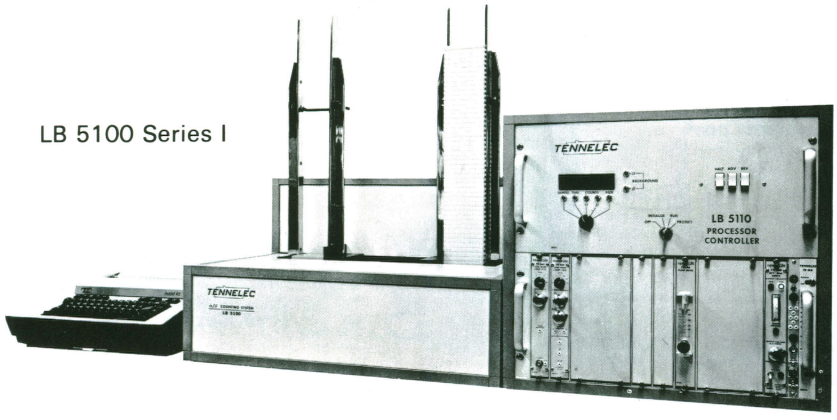
CAB-8	8.75″ high
CAB-12	11.75″ high
CAB-17	17.50″ high
CAB-22	22.75″ high

- All are 19″ wide and 21.5″ deep

LB 5100 SERIES I and II

Automatic Low Background Alpha/Beta Counting Systems

LB 5100 Series I



- Simultaneous alpha and beta counting with minimal crosstalk
- Accommodates up to 2" diameter samples
- Ultra-low background
- Rapid sample changing
- System operation diagnostics
- 2 sigma calculations
- Sample group analysis
- Data plotting
- Easy access detector slide assembly
- Automatic background subtraction
- Independent alpha and beta concentration calculation
- Accommodates 50 or 100 samples
- Power interrupt indicator
- Operates on P-10 gas

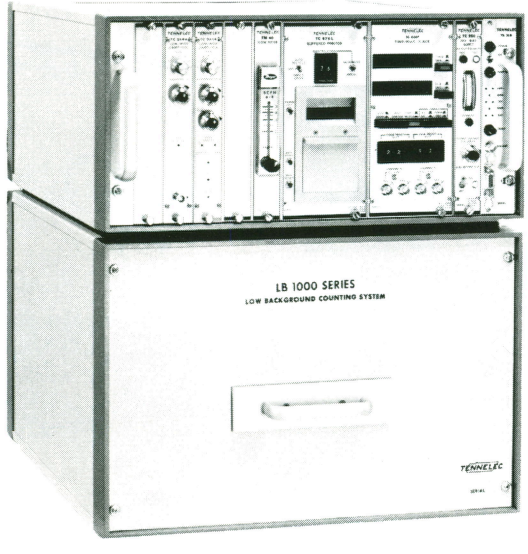
LBA-01

Mobile Cabinet

- For LB 5100 Series Systems
- Rugged steel construction
- 5" wheels
- Lift-up table for terminal/printer
- Fits through standard size doorways

LB 1000 SERIES

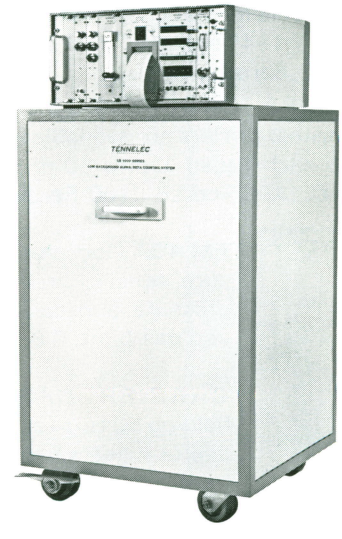
Manual Low Background Alpha/Beta Counting System



- Simultaneous alpha and beta counting, with minimal crosstalk
- Accommodates up to 2" diameter samples
- Ultra-low background
- Precise sample positioning
- Easy access detector slide assembly
- Power interrupt indicator
- Operates on P-10 gas
- NIM modular design

LBM-01

Mobile Cabinet

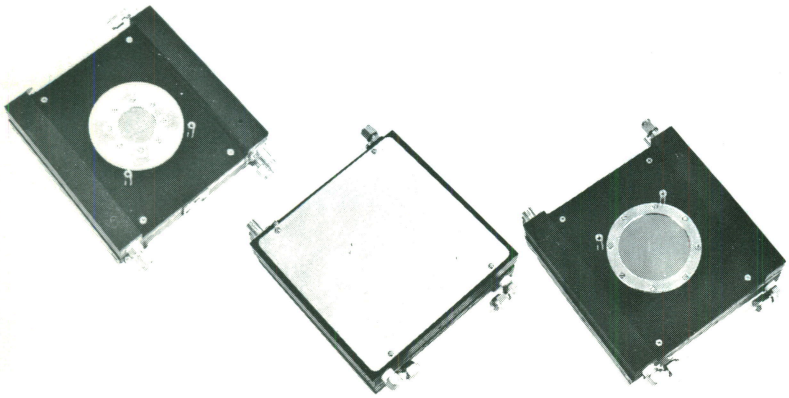


- For LB 1000 Series Systems
- Rugged steel construction
- 5" wheels
- Rear access door

LB SERIES

Proportional Counters

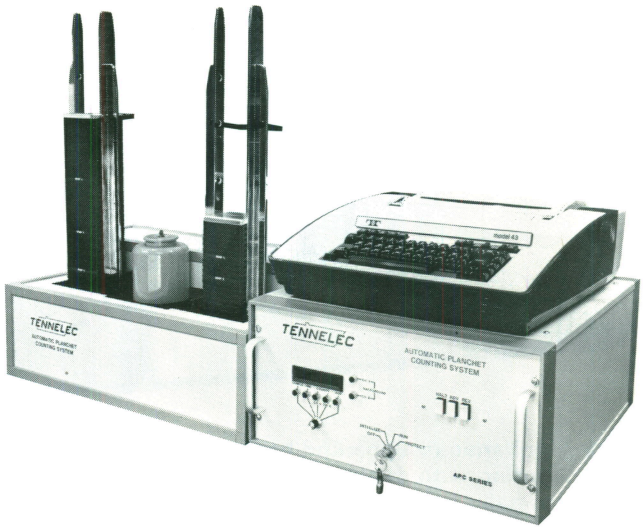
MODEL	DETECTOR DIAMETER	WINDOW DENSITY
LB 1500/LBG 25	1.25 inches	500 μgm/cm^2
LB 1080/LBG 25	1.25 inches	80 μgm/cm^2
LB 2500/LBG 25	2.25 inches	500 μgm/cm^2
LB 2080/LBG 25	2.25 inches	80 μgm/cm^2



- Large area proportional counters for LB 1000 and LB 5100 Series Systems
- Suppresses high energy cosmic radiation
- Rugged and reliable
- Easily removable window
- Designed and manufactured by TENNELEC
- Four models available

APC SERIES

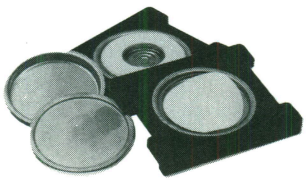
Automatic Planchet Counting System



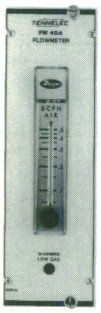
- 50 or 100 sample capacity
- Constant sample face to detector spacing
- 1/16", 1/8", 1/4", or 5/16" thick samples
- 1 second sample changeover time
- 1.75" diameter GM detector
- Calculates activity in dpm, microcuries per liter, etc.
- 2 sigma percent error calculation

LB & APC ACCESSORIES

CARRIER INSERTS 1" or 2" diameter stainless steel carrier inserts are available for planchets that are 1/16", 1/8", 1/4" or 5/16" thick (APC & LB 5100 Series)



SPARE CARRIERS BCD coded decimal carriers are available in lots of 50 each coded 1 thru 50 or 51 thru 100. (APC and LB 5100 Series)



FM 40A Flow meter with built-in gas pressure sensor, circuitry to indicate low gas pressure and disable system high voltage and gas filter. (LB 5100 & LB 1000 Series)

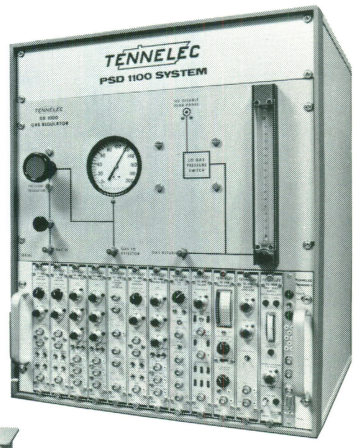
CARRIER CASSETTES Capable of holding 50 carriers, these cassettes are very useful when samples must be transported from a preparation laboratory to be loaded onto the LB 5100 and APC Series systems.

SPARE WINDOWS 2.25" and 1.25" diameter windows either 500 μgm/cm^2 or 80 μgm/cm^2 thick are available. Other thickness windows are available on special request. (LB 1000 and LB 5100 Series)

* Contact TENNELEC for a more comprehensive list of available accessories.

PSD 1100

X-Ray Position Sensitive Detector System



- $\leqslant$ 200 micron position resolution guaranteed — 150 microns typical
- Operates from 1 to 10 atmospheres
- $<$ 1.1 keV resolution for 5.9 keV x-rays
- $\leqslant$ 1% position linearity
- $>$ 90% detection and counting efficiency for 8 keV x-rays
- Detector active area, 4 mm x 80 mm

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601 Oak Ridge Turnpike
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TENNELEC INC.

CONDENSED CATALOG

NAME

TITLE

DEPARTMENT

ORGANIZATION

ADDRESS (STREET/P.O. BOX)

(CITY) (STATE/COUNTRY) (ZIP)

TELEPHONE (_____) _____

The above is ☐ is not ☐ a change of address.

☐ Add my name to mail list per interest described below

☐ Delete my name from mail list

I am interested in:

☐ NIM Electronics

☐ Silicon Charged Particle Detectors

☐ Low Background Alpha/Beta Counting Systems

☐ Automatic Planchet Counting System

☐ X-Ray Position Sensitive Detector System

☐ Other — Please describe:

My requirements are:

☐ Immediate ☐ 90-120 days ☐ Information only

CC 30K 183

TENNELEC INC.

CONDENSED CATALOG

NAME

TITLE

DEPARTMENT

ORGANIZATION

ADDRESS (STREET/P.O. BOX)

(CITY) (STATE/COUNTRY) (ZIP)

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☐ Other — Please describe:

My requirements are:

☐ Immediate ☐ 90-120 days ☐ Information only

CC 30K 183

TENNELEC 1980's

TENNELEC has long been known as a pioneer furthering the technology of nuclear pulse measurements.

Founded in 1960 by Edward Fairstein, one of the world's leading designers and authors in the nuclear electronics field, TENNELEC has continually strived to develop and provide the highest performance most reliable instrumentation available for nuclear research.

During 1960, when silicon semiconductor detectors were introduced, TENNELEC immediately set the standards of performance for the entire industry by designing and manufacturing the very first ultra-low-noise, charge-sensitive preamplifier. With the advent of sufficiently advanced transistor technology in 1964, TENNELEC developed and shipped the model TC 200 Linear Amplifier. The TC 200, using an "active element" pulse shaping technique, represented a radical departure from that which had previously been available in linear amplifiers. Built to TENNELEC's most stringent requirements for performance and reliability, the TC 200 quickly became the laboratory standard throughout the world, with many still in productive use today. Since that time, TENNELEC has continued to expand its line of instrumentation while maintaining the most rigid guidelines for performance and reliability.

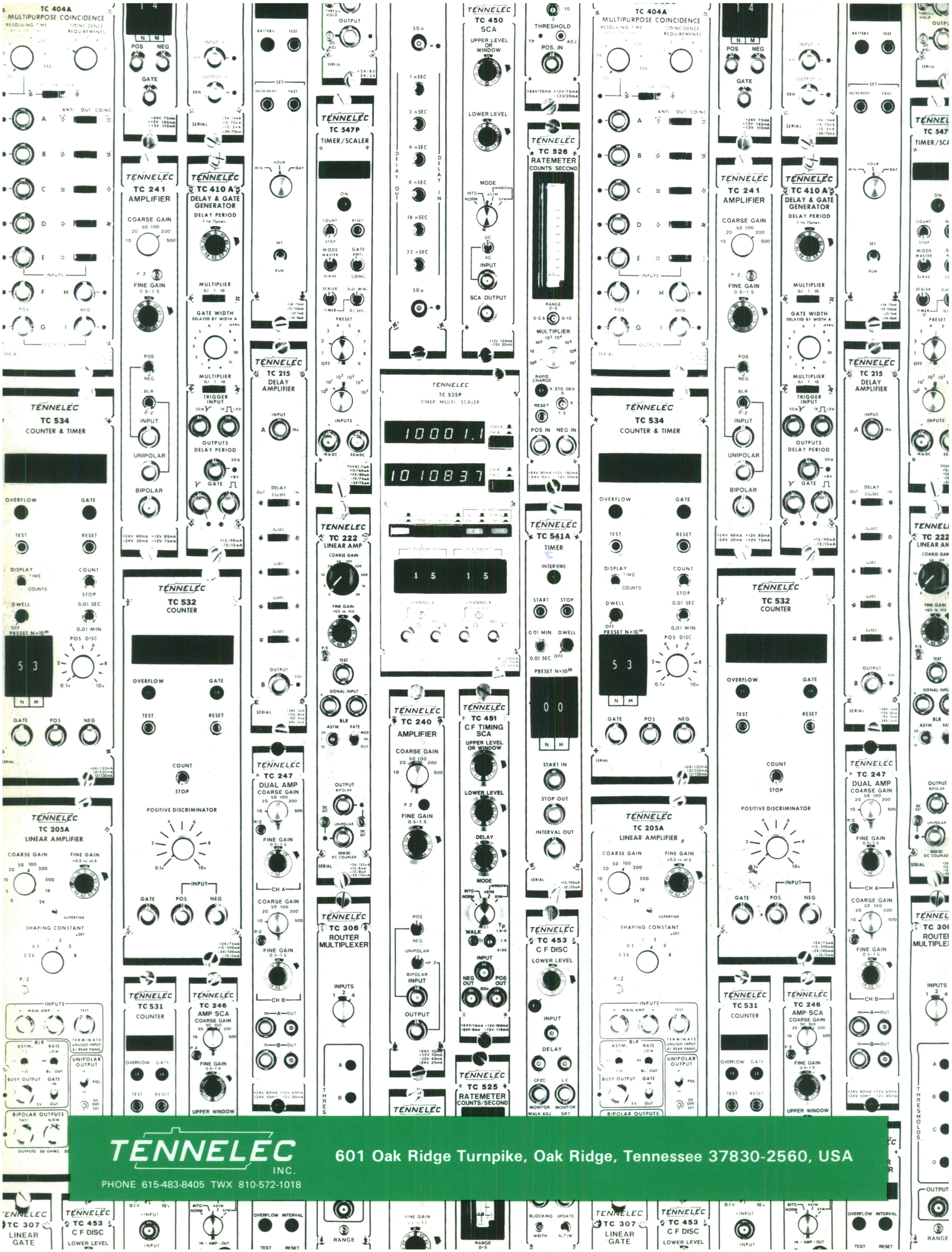
The 1980's are here and so are the challenges every new decade seems to bring. New and better instrumentation is needed to meet the requirements of the scientific community. Costs, as never before, must be held at a minimum without sacrificing product quality and reliability. TENNELEC is meeting these challenges.

The descriptions of the instruments in this condensed catalog are brief in an effort to provide some information about all of TENNELEC's products. Please use the reply postcard provided or call us or our representative directly if we can assist you in any way.

TENNELEC INC.

601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830-2560, USA

PHONE 615-483-8405 TWX 810-572-1018



TENNELEC INC.
601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830-2560, USA
PHONE 615-483-8405 TWX 810-572-1018